The practical role and application of Cooperative Game Design Principles in game design processes

by

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Abstract

In this paper we seek to investigate the practical role that cooperative game design principles (CGDPs) can play in the design & development of two-player local co-op videogames (Kultima, 2018; Kultima & Sandovar, 2019). We decided to take a practical approach to answer our research question by developing a game demo. In this paper, describe the design framework, our design & development process and report on players' experience with our demo. With regards to the role of the design principles, we observed that they did have a positive impact on both our process and that they were reflected in the players' experience. We conclude that design principles can play the role of goals for the player experience and game, general attitude to the process, and practical guides to make choices during development. When setting the GDP of a game-project it's important to identify which roles they will play in the process.

1. Introduction

The topic of game design methodologies, methods and processes has been the subject of study and analysis of various game scholars and designers. However, there is a lack of journals and papers that report on and evaluate their application, as both Neil (2012) and Almeida & da Silva (2013) highlight from their reviews on game design methods. With this thesis project, we seek to address this gap through the design and development of a videogame demo and the writing of this thesis.

In this first chapter, we give a brief overview of the literature highlighting the need for more practical evaluations of game design tools, state our research question and present our project. In the second chapter, *Design Framework*, we present the game design methods that we have used to build our game design process. In the third and fourth chapters, *Design & Development Process* and *Players' Experience*, we will describe our results, which will constitute the data used to answer our research question. We will then provide an *Analysis* and a *Discussion* of these results in the fifth and sixth chapters.

1.1. On the lack of qualitative data about game designers' and developers' use of design methods

In *A Systematic Review of Game Design Methods and Tools* (2013) Almeida & da Silva point out that there is still a lack of "a shared tool box containing both broad application solutions and specific to certain genres of games", and that the challenge is to develop tools that do not limit the creativity that is a fundamental part of design (Almeida & da Silva, 2013, p.26). In *Game Design tools: Time to evaluate* (2012), Katharine Neil also highlights three areas of research still open. Firstly, there is a lack of ideation tools to support design during the ideation phase. Secondly, there is a lack of tools for "reasoning about and visualizing systems of game mechanics" (Nelson & Mateas, 2009). And third, as Joris Dormans (2009) observes, formal models for game design are rarely used in practice. According to Dormans, this is because these models would require designers to invest time and effort into learning a new paradigm without any evidence of its usefulness in tackling the problems that they are encountering. This is why Neil (2012) points out that there is a need for more qualitative data on if and how well game design tools and methods support and improve the game design process.

Neil (2012) discusses a few different types of tools used during the game design process. Similarly, Almeida & da Silva's (2013) paper also maps out various game design tools and methods. According to Neil, diagramming, which consists of visualizing how the various elements of complex systems are connected to each other, is mainly used for "user interfaces, narrative flow, maps, screen wireframes and statistics" (Neil, 2012, p.3), while natural language is the main tool used to express

game mechanics[1] and rules. However, it can be noted that diagramming can be useful to visualize and explain game loops, game systems and game mechanics. For example, according to Librande (2010), diagramming is a useful tool to identify key elements of a game's gameplay[2], to show the relationships between different components of gameplay, and to break down problems into smaller and more manageable pieces. Additionally, Librande (2010) also points out that diagrams are easy to understand and update. In their paper, Almeida & da Silva discuss a few tools used for visualizing gameplay design into diagrams, such as the software CAGE (Kuittinen, 2008), Sketch-It-Up! (Karakaya et al., 2009) and Machinations (Dormans, 2009). With regards to natural language tools, Almeida & da Silva discuss the issues of Game Design Document as a design tool: even those aided by sketches and diagrams seem to be inherently static, and especially those that are more reliant on the written word to communicate the design tend not to be used in practice during development (Costikyan, 1994; Kreimeier, 2003; Librande, 2010).

Both Neil and Almeida & da Silva also discuss prototyping and the difficulties of the jump from design documentation to the creation of game prototypes. As Neil explains, prototyping is used "to evaluate the quality of design ideas" (Neil, 2012, p.3), checking if the design goals are being accomplished and if the actual player experience matches the intended player experience. Prototyping can also be used for experimentation (Salen & Zimmerman, 2003), however, in order to make a prototype, design usually needs to be already quite defined, so it is difficult to include this method in the initial game conception phase (Almeida & da Silva, 2013). As Neil notes, the passage from game design documentation and game prototype can encounter many difficulties. Neil observes that one way to solve this would be to make prototyping more accessible for designers, but that current methods to do so are still imperfect solutions. Paper prototyping, for example, is not suitable for all types of games, while simplified production tools tend to limit the designer's creativity. The gap from the design to prototyping still remains a difficult jump to go through for designers and developers.

1.2. Our research question on the practical application of game design principles

In *Game Design Values* (2019), Annakaisa Kulima and Alyea Sandovar discuss previous research on the topic of design values, such as Lawson's Guiding Principles (Lawson, 2005), Holm's Designers' Distinctive Design Values (Holm, 2006), Schön's Appreciative Systems (Schön, 1983), as well as previous work from both Kultima and

[1] ***Game mechanics.*** For the purposes of our thesis and project, while working we define game mechanics as Bernard did in *Local Multiplayer Games* (2022): game mechanics are a set of rules for player actions and the game's reaction to them, which can often be seen as a system of interactions between player and game.
[2] ***Gameplay.*** The system of game mechanics and rules that determine how the players can interact with the game's environment and each other, and the feedback given by the game in response to these interactions.

Sandovar. Similarly to what Neil and Almeida & da Silva note about the lack of reports on the application of game design methods, Kultima & Sandovar argue that there is a lack of research "on the actual day-to-day value systems of game developers" (Kultima & Sandovar, 2019, p.3). Since then, there have been a few papers that took a qualitative approach to researching the game design methods and values used by game designers and developers in practice, such as Kankainen & Paavilainen (2019) who used workshops with industry experts to define guidelines for hybrid games or Hawey (2025) who also discusses game design values while reporting on the practices of game artists. On the topic of cooperative videogames there are the works of Bernard, (2022), who prototyped a cooperative game based on research on the genre of local multiplayer games, and Nyblom (2023), who compared the designers' intended player experience of *Coridden* (Aftnareld, 2025) with the perceived player experience of actual players, both of which however did not touch on the topic of game design values.

In our thesis project, we decided to investigate the topic of game design values and the role they play in the design & development process of videogames, with a focus on cooperative videogames, and to seek to answer the following research question: ***How can cooperative game design principles shape game design processes, and how can the player experience reflect these design principles?*** To answer this question, we decided to use research through design as our research approach (Lankoski & Holopainen, 2017) and developed a videogame demo. In the *Design Framework* chapter, we explain how we define the game design values that we set for this project and present the game design methods that we used to pursue them. Our report in the *Design & Development Process* chapter allows us to analyze the role that game design values have played in our process. Our report in the *Players' Experience* chapter will provide the data needed to evaluate how much the practical application of our chosen game design methods helped us to achieve our design values in relation to the players' experience.

1.4. Developing a cooperative videogame demo

For this thesis project, we decided to make a videogame demo, specifically a two-player local cooperative videogame. The demo is a short (approximately 15 min of gameplay) 3D puzzle-platformer where one player character has the ability to push/repel objects and the other to pull/attract them: the two players will have to coordinate and combine the use of these abilities to overcome obstacles and reach the end of the game's level. During the design and development of this demo we gave ourselves the roles shown in *Table 1*, which we mention when presenting our *Design & Development Process*.

	Main Role(s)	Secondary Role(s)
Hanna Katriina Salomaa	● Art Direction	● Level Artist ● Asset Creator
Hallur Kristinn Hallsson	● Tech Lead ● Systems Architect	● Programmer
Laura DeCarli	● Lead Game Designer ● Producer	● Gameplay Designer ● Level Designer ● User Experience Designer and Researcher ● User Interface Designer
Mikkel Iuel	● Game Designer	● Gameplay Designer ● Level Designer ● User Experience Designer

Table 1. *The roles that each team member covered while developing the demo for this thesis. Split into main and secondary roles along the horizontal and by Team member along the vertical.*

Cooperative games can be defined as games that put an emphasis on play, "participation, challenge, and fun" over competition or defeating someone (Aghabeigi, 2010, p.12). We decided to develop a cooperative videogame because the challenges of developing this genre of videogames makes them well suited for us to test out our methods for player-centered design. The design and development of all games needs to take into consideration the fact that they will be played by someone, and in the vast majority of cases centering the player's experience is key to making a game that effectively reaches its creators' goals (Fernández-Vara, 2019; Schell, 2015). Therefore, even when creating games that are not particularly concerned with the player's experience for one reason or another, the fact that games are a medium based on interaction cannot be avoided. Cooperative videogames make this fact even more evident, as they cannot be played in the absence of another player to play with. Rather, the games' purpose in this case becomes, specifically, that of enabling cooperative play between two or more players (Bernard, 2022).

2. Design Framework

Before starting to ideate, design and develop our game, we defined what our design process would be by researching game design methods, methodologies and processes. In this thesis, we will adopt Neil's definition of game design as the act of crafting the core player experience in terms of gameplay and rules (*Game Design tools: Time to evaluate*. 2012). For purposes of this thesis, we will also define methods as specific tools, techniques and procedures used to design, develop and test games, while the term methodology refers to the overall framework and approach used to design (Bryman, 2008). Additionally, when discussing game design processes we are referring to the actual steps taken to design, which include the use of methods that fit within a methodology.

Throughout this thesis, we will refer to our videogame project as either a prototype or as a demo. For the purposes of our thesis and project, a prototype is defined as a stage in the development of the game in which an executable is produced containing the game's main game mechanics, examples of challenges and interactions between the players and the game world. During this phase there is no game art or audio implemented and the visual representation of the players and level consists of basic 3D shapes. When referring to the demo we are instead talking about the build[3] made to accompany our thesis' paper, which is also the build used for the playtests that we will present in the *Players' Experience* chapter. It is not the finished game, and it does not contain all the features that we want in the finished game, but it is a demonstration of what the game's gameplay and level design would look like.

This chapter provides a literature review of the design methods we have used: identifying game design constraints (Lawson, 2005) and game design principles (Kultima, 2018; Kultima & Sandovar, 2019), ideation methods (Kultima, 2010; Pranes, 1961; Sowrey, 1990), player-centered design (Fullerton, 2024; Hagen, 2012; Nyblom, 2023; Sykes & Federoff, 2006), cooperative game design patterns (Aghabeigi, 2010; Jonassen, 2017), diagramming (Librande, 2010; Neil, 2012), sketching and iterative design (Adams, 2009; Cuthbert, 2013; Kultima, 2015). As this paper investigates the question of "How can cooperative game design principles shape game design processes, and how can the player experience reflect these design principles?", the first section of this chapter focuses on how we defined the cooperative game design principles specific to our demo.

[3] ***Build.*** A build is an executable file of a videogame.

2.1. Before ideation

Our first step in defining our game design process has been to identify our game design constraints, and to define our design values to translate into design principles. Identifying and defining constraints and principles has the purpose of better orienting ourselves both during the ideation phase and while making design decisions during development.

2.1.1. Game Design Constraints

Design constraints give direction to the design process and decisions and often come from four sources: (1) the clients who present a task or problem to the designers, (2) the users who will actually use the implementation of the design, (3) the designers themselves with their own values, skills and creative practices, and (4) legislation which gives guidelines and standard codes of practice (Lawson, 2005. pp.84-89). For our project, we defined design constraints as any constraints, either imposed by production circumstances or self-imposed, that have put hard boundaries on what we could and want to create.

2.1.1.1. Example: Our Game Design Constraints

First, we identified the constraints imposed by our production circumstances:

- **Team composition:** we are one game developer, one artist and two game designers, we cannot design anything that cannot be implemented with this team composition.
- **Team skill levels:** what we could do was limited by what we knew how to do and how quickly we can learn to do new things if needed.
- **Time available:** we had 16 weeks for the project and paper, so the scope of both the project and the paper needed to fit this timeframe.
- **Game duration:** the demo should not exceed 15 min of gameplay, or it would be too difficult to schedule the playtests to gather data on the players' experience and we would risk overscoping our data.

Then we defined our self-imposed constraints:

- We wanted to create a two-player local cooperative game.
- We wanted to create a 3D game.
- We wanted to create the demo in Unity.
- We needed a demo of which the development would allow us to answer the research question of "How can cooperative game design principles shape game design processes, and how can the player experience reflect these design principles?", so we need to set for ourselves a set of design principles that must include cooperative game design principles.

2.1.2. Game Design Principles

As already mentioned in the *Introduction*, Kultima & Sandovar (2019) have conducted a literature review on the topic of game design values. From their analysis, they then describe sets of game design process values that can be seen in contemporary game development and divide them into nine categories: (1) values of player centrism, (2) casual game design values, (3) traditional game design values, (4) values of artistic expression, innovation and experimentation, (5) ludological values, (6) societal impact and cultural values, (7) values of production and creation process, (8) values of independency, and (9) values of commercial success or sustainability. Each category contains different game design values, as shown in *Table 2*:

Category	Design Values
Values of Player Centrism: these values highlight player-centric design as the preferable starting point for game design	• Players' advocacy • Co-creativity and user inclusion • Usability and playability
Casual Game Design Values: usually come into play when designing games for mass markets	• Accessibility (ease of play and easy to acquire) • Acceptability • Flexibility • Simplicity
Traditional Game Design Values: the design process of traditional games often values the these features	• Immersion • Challenge and competition • Community • Other–worldliness
Value of Artistic Expression, Innovation and Experimentation: are usually centered in the design process of videogames that are used as a medium for artistic exploration	• Visual design and aesthetics • Experimentation • Divergent design
Ludological Values: identify the "core" of what makes experiencing a game than experiencing other mediums	• Enjoyment and value of fun • Technological agnosticism • Nostalgia and retro aesthetics • Value of game mechanics
Societal Impact and Cultural Values: these values are usually centered in videogames whose creators base their design choices of a specific social agenda	• Games for good and impactful games • Diversity and accessibility • Ethics and morality • Cultural diversity and tradition
Values of Production and Creation Process: refer to development culture, quality of the result of the production and/or collaborativeness in the production process	• Peer respect and professional identity • Collaboration and value of teamwork • Open source ideology • Polish and details • Technological advancement • Development as a challenge

Category	Design Values
Values of independency: "For many creators, cultivating autonomy and freedom in their work is the single most important value. This value is based on the belief that it is important to create artifacts that depict honest and true design decisions that are not dictated by outside commercial requirements or those that align with mass appeal."	● Autonomy and artistic freedom ● Anarchy
Values of Commercial: become more central when economical sustainability are an important goal	● Economic success ● Opportunism and disruption

Table 2. *"Multitude of design values in the field of game design" as introduced by (Kultima & Sandovar, 2019, p.6)*

It is important to note that game design values are both very team-specific and very project-specific: different teams are composed by different people and different projects are made with different goals, which will result in different sets of game design principles. For example, while we would like to be able to publish our game, economic success is not a goal that we are striving for in this project, but, aside from that, every other category of design values described by Kultima & Sandovar has been relevant for us to reflect on. Despite being specific to each team and project, the team's agreement and understanding on their project's game design values are key both from a production and a design perspective, and should be aligned with regards to what the team wants to create and how they want to work.

2.1.2.1. Defining our demo's game design principles

Game design principles originate from the value systems of the people involved in their creation. Therefore, our first step for creating a list of game design principles for our demo has been to discuss and define the game design values we wanted to set for ourselves and the demo itself, we held a meeting to discuss our general goals for the demo and took time to reflect on how we wanted to work on it together as a team. The meeting about our goals for the demo allowed us to define our game design values regarding the intended players' experience and the game. The reflections on how we wanted to work together instead gave us space to communicate to each other what we wanted to learn, what expectations we had from each other and our boundaries, thus defining a set of game design values centered on the team.

When discussing what kind of videogame we wanted to make we structured the meeting around answering a few questions [*Figure 1.*]: "What types of design and development approaches we'd like to use?", "What are the player characters?" "What do the player characters do? (mechanics wise)", "Where does the game take place?", "What do we want the players to feel/experience?". We also talked about other

examples of two-player cooperative games and what we thought made them interesting or work well as cooperative games.

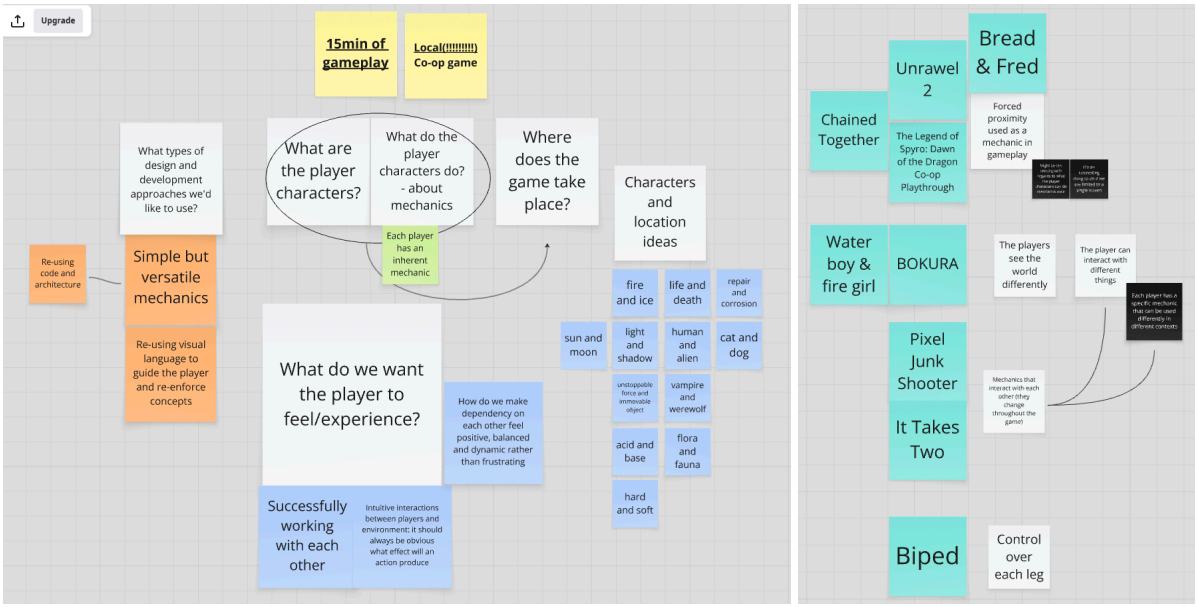


Figure 1. *Screenshots of the board we used while discussing to get an initial general idea of what we'd like to do for the demo. On the left is our early ideation where we were brainstorming limitations and concepts for how we wanted to work and what our demo would be. On the right you will see what games we took as inspiration and how we categorized them into different categories depending on what the games defining mechanic was and what their limitations are.*

From this discussion, we were able to define game design values that, by referencing Kultima & Sandovar's paper (2019) we can situate in the categories of "Values of Player Centrism", "Casual Game Design Values", "Ludological Values" and "Values of Production and Creation Process". From the values that we discussed about, we then produced a list of game design principles, which we grouped as either "centered on the game", as in the content of the demo, or "centered on the players", as in the players' experience. Since our research question is specifically about cooperative game design principles, we will dedicate a separate section [2.1.2.2.] of this chapter to expand on the topic of cooperative game design.

Game design principles centered on the game:

- Creating an environment that communicates to the player in an aesthetically cohesive manner.
- Gameplay should support cooperative play.
- Player character abilities should be asymmetric and equally fun for both players.
- Level design and game mechanics should integrate well with each other.
- Game mechanics need to be simple to implement while allowing varied experiences.

Game design principles centred on the players:

- The experience should be enjoyable by both players even if they have different videogame literacy levels.
- The player experience needs to be fun and interesting, not necessarily difficult.
- The game should enable players to have fun with each other.
- The collaboration should feel satisfying for both players together
- Intuitive interactions between players and environment: it should always be obvious what effect an action will produce.
- How do we make dependency on each other feel positive, balanced and dynamic rather than frustrating.

The values that emerged from our reflections on how we wanted to work can instead be situated in the category of “Values of Production and Creation Process”. To identify them Laura (Producer) asked the team the following questions: “What are our objectives as a team for the thesis’ project demo?”, “What are each team member’s learning objectives for this thesis project?”, “What roles would each team member cover, which roles are they comfortable with in general and which ones are they not comfortable with?”, “What will be each team member’s general availability during the semester?”, “Are there any work boundaries (for yourself) that you want to set?”, “During group projects, what expectations do you usually have of other team members?”, “Is there anything that you usually struggle with in group projects that the other team members should be aware of to help each other out?”. From the answers to these questions, we were able to define a set of game design principles centered on us as a team.

Game design principles centered on the team:

- We want to learn efficient iteration practices.
- We want to learn how to efficiently communicate information visually.
- We want to learn how to design gameplay and game mechanics for local two-player cooperative games.
- We want to learn how to design for simplicity of implementation and variety in the player’s experience.
- Direct, honest, calm and respectful communication: don't hesitate to say when you're encountering problems, need help or when something another team member's work has flaws that should be worked on.
- Communicate how your work is progressing to minimize issues with dependencies.
- Respect boundaries about how much and when other team members can and want to work.

2.1.2.2. Cooperative game design patterns and guidelines

Since we decided to create a local cooperative videogame demo, we also researched cooperative game design patterns to better define our cooperative game design principles. Aghabeigi (2010) defines game design patterns as "a specific set of design choices concerning rules or mechanics which can be applied to solve similar design challenges or problems" (p.X). Our main references for cooperative game design patterns have been Bardia Aghabeigi's *Understanding and Evaluating Cooperative Video Games* (2010) and Alexander Jonassen's *Designing For Couch Co-Op - 11 game design guidelines promoting player cooperation* (2017). Aghabeigi (2010) identified and analyzed cooperative videogame design patterns and developed validated metrics to evaluate the player's experience in cooperative games, both of which will be a reference for our work. Jonassen (2017) instead conducted a meta-analysis of game design guidelines and recommendations for cooperative videogames from actors in the game industry, with a focus on local cooperative games, and then sorted them into clusters and created a set of generalized design guidelines.

For the purposes of having a unified list of cooperative game design patterns to reflect on when ideating and designing our demo, we put together Aghabeigi's and Jonassen's lists of design patterns. We used many of these patterns as cooperative game design principles during the ideation phase to evaluate which ideas would work better as a starting point for design, as well as during the design & production process of the demo:

- *Complementarity* between the two player character roles and/or activities (Aghabeigi, 2017). This allows *players to take on specialized and inter-dependent roles and avoiding allowing one player to do all the work* (Jonassen, 2017).
- Creating *Synergies between abilities* by allowing one player character to "assist or change the abilities of another" and by defining "rewarding rules in a way that consider the performance of all players with different abilities" (Aghabeigi, 2010).
- *Encouraging communication and teamwork by allowing players to make choices together and complementing each other* (Jonassen, 2017).
- *Shared goals* that give a reason for the players to work together (Aghabeigi, 2010).
- *Incentivizing cooperative behavior by making it additive to the gameplay and not restrictive* (Jonassen, 2017).
- There are three main *Camera setting* design choices that have been proven successful when developing the camera for cooperative games: "split screen horizontally or vertically, one character in focus, all characters are in focus (the screen doesn't move unless all characters are near each other)" (Aghabeigi, 2010).
- Having both players *interacting with the same object* (Aghabeigi, 2010).

- Presenting players with *Shared Puzzles* (Aghabeigi, 2010).
- *Designing for a range of skill levels allows players with different experience levels and accessible to players with disabilities* (Jonassen, 2017). Couch cooperative games, for example, are often played by players who don't have the same amount of game or game-genre literacy, and should try to be as accessible as possible to players with disabilities. This means that the situations the players are presented with should have a lower level of difficulty, to be accessible to first-time players, but interesting enough to still be enjoyable by eventual more skilled co-players. It also means making accommodations wherever possible (e.g.: choice of color palette, accessible input systems, control schemes, etc.).
- *Provide different game modes or rule settings* (Jonassen, 2017). For this guideline, Jonassen focuses mainly on the topic of difficulty modes and allowing players to adjust rules and win-conditions.

Aghabeigi and Jonassen also list patterns that would probably improve the cooperative play experience, but are not essential to have for our demo:

- Giving players the possibility to communicate through simple *Vocalizations* (e.g. alerting, pointing, etc.) (Aghabeigi, 2010).
- *Making it easy to rotate in and out of gameplay* (Jonassen, 2017). This guideline refers more to party games with many players, in which case the game should allow players who don't want to play anymore to easily leave the game without negatively affecting the current playthrough.
- *Allowing players to self-express* (Jonassen, 2017). The self-expression discussed here by Jonassen is about encouraging different styles of play or avatar customization.

It is important to note that these guidelines and design patterns are not a checklist of must-have features, but rather they are useful references to define the goals that a design is meant to achieve, and not all of them apply to all cooperative games. For example, the following patterns listed by Aghabeigi and Jonassen are not relevant for the project that we set out to do:

- *Synergies between goals* that, while being different goals for different players, still affect each other and succeeding in one will contribute to succeeding in the other (Aghabeigi, 2010).
- *Downplaying inter-group competition by avoiding individual rankings and making the group win or losing collectively* (Jonassen, 2017).
- *Special rules* that "enforce cooperation within teams" by having the game provide specific feedback to positive actions performed on a friendly player (Aghabeigi, 2010).
- Providing players with *Shared Characters* (Aghabeigi, 2010).
- Providing players with *Limited resources* (Aghabeigi, 2010).
- Including *Special characters targeting the lone wolf* (Aghabeigi, 2010).

While others are just goals we chose not to focus on:

- *Abilities that can only be used on another player* and that "can encourage cooperative game-play", for example simple interactions to emote to and with the other player character (Aghabeigi, 2010). These abilities are designed with the objective *of eliciting pro-social player interaction by allowing players to perform positive social interactions and/or allow only supportive behaviour* (Jonassen, 2017). Examples of pro-social player interactions are "giving, sharing, contributing, helping, healing, inviting, greeting, trading, sharing, commenting and liking" (Jonassen, 2017).
- *Designing for the meta-game* (Jonassen, 2017). This guideline is about considering the social context in which the game is played. Voida & Greenberg (2009) invite to put the player's social experience in the context of "the larger ecology of shared media", Kim, (2013) suggests to take user generated content into consideration, while Salen & Zimmerman (2003) pose the questions of "What does a player bring to a game? What does a player take from a game? What happens between games? What happens during a game?".
- *Fostering an enjoyable experience for the audience* (Jonassen, 2017). Jonassen's analysis also invites to consider how to make the game entertaining for the audience, or allowing the audience to participate.

2.2. Player-Centered Design

Since a good portion of our *Game Design Principles* centered the players and their experience with the game, before starting to ideate and design our demo we also researched player-centered design methods that we could include in our game design process.

In *Player experiences in the game Coridden* (2023), Nyblom conducts a case study of *Coridden* (Aftnareld, 2025) to examine both the player experience intended by the designers and the actual player experience of playing the game, with the objective of studying how to better align the two and providing guidelines for the design and development process of other games. The main insight that we took from Nyblom's work and incorporated into our design process was the idea of using player experiences as design guidelines. As Fullerton (2019) argues, it's important to set the goals for the player experience, presented as descriptions of situations the players should find themselves in, early-on in the design process. Similarly, Hagen (2012) explains that many game development studios focus more on designing for a player experience rather than specific features.

In Player-Centered Game Design (2006), Sykes & Federoff seek to identify user-centered design techniques that are appropriate for game design, from concept development, to pre-production and production. During the concept development phase, it is important to identify what are the design constraints generated by the

target audience, as different audiences have different needs and expectations. In our case, for example, we have to make a videogame demo that is playable by two people and we need to recognize that one or both of them might be players with lower levels of gaming experience. Sykes & Federoff present two user-centered design techniques to use during this phase: user profiling methods (e.g. personae), like models of different player types (Charles et al., 2005), and Zimmerman's suggestion to include players in the iterative design process to evaluate elements of the concept (Zimmerman, 2003). During pre-production, it can be useful to develop a single level to a standard, playtest it with the target audience, and from that feedback extrapolate the gameplay across the remaining levels (Sykes & Federoff, 2006, p.3). While during production, usability testing allows us to quantify the playtesters' emotional responses to the game and to detect both design and technical problems (Sykes & Federoff, 2006, p.3). As for the post-production phase, analyzing the player's responses to the game and the reviews is a way to better understand the game's target audience and to gather feedback to improve future sequels or new games made for the same target audience.

In our project, we decided to conduct playtesting with external playtesters[4] during our prototyping phase in order to evaluate our design with their feedback and the observations we made of how they interacted with our prototype. We used this method, as described in the *Playtesting for iterative gameplay* section of this chapter, throughout the rest of the production of the demo, as it allowed us to gather the information needed to refine and adjust the level design.

2.3. Ideation Methods

An important part of the design process is ideation, which is used both to come up with an initial design concept and to solve design problems that come up during development. In this section, we briefly introduce some ideation methods, while in the *Design & Development Process* chapter we describe how we ideated the gameplay, level design and visual representation of our demo.

In *The Organic Nature of Game Ideation: Game Ideas Arise from Solitude and Mature by Bouncing* (2010), Annakaisa Kultima interviewed game designers and other game professionals in order to identify and present different types of ideation techniques, dividing them between informal and formal ideation techniques. Kultima's paper gives us clear language to describe and explain what we as designers are doing during the ideation process. It also allows us to clarify what the main goal of ideation is: the purpose of the starting idea(s) is to help designers and the other members of the team to begin to design and develop the game's concept in more concrete terms.

[4] **External playtesters.** People who are not involved in the design and production of our project who test the project by playing it.

In general, but especially when coming up with a game concept, ideation serves as a starting point of design: it is not a fundamental element of the game itself, what it needs to do is to get the design work started, and most ideas will often change throughout the process (Kultima, 2010). Therefore, a good idea is one that can inspire the process of the rest of the team and allows the team to build the design upon it (Kultima, 2010).

Ideation is often hindered by self-criticism and ideation techniques, both individual and group sessions, can be used to counter these obstacles (Kultima, 2010). By interviewing game designers and professionals, Kultima (2010) presents different types of ideation techniques, most of which are informal with brainstorming encompassing the more formal techniques. The purpose of ideation techniques is not only that of creating a game concept, but also of coming up with improvements (Kultima, 2010) or solving problems.

Informal ideation techniques

- *Seeking inspiration*. Inspiration for games ideas can come from any source (other media, life experiences, conversations, etc.) and seeking inspiration is more an attitude than a technique, as it's about being curious about many things and thinking creatively about them.
- *Purposeful activities*. Doing other things, while reflecting on an idea, like going for a walk, being in a natural environment or sketching to visualize it, is useful when trying to develop it further.
- *Bouncing the ideas.* Once an idea is there, it can be bounced off other designers who might be inspired by it and develop it more, or get new ideas. Group sessions are thus usually used both to develop a starting idea or to generate more ideas in collaboration.

Formal ideation techniques:

- *Brainstorming*. The moderation skills of the conductor are vital to the success of a brainstorming session, as it needs to be a structured and guided process with the objective of producing as many ideas as possible (Kultima, 2010; Pranes, 1961; Sowrey, 1990).

2.4. Design Methods

The starting idea that resulted from our design principles and ideation is the following:

> We want to make a 3D local cooperative videogame with two players. One player character will be able to Push/Repel objects, while the other will be able to Pull/Attract objects. Both players' abilities will have two modes, single-target and area-of-effect, both with three levels of intensity.

This section presents the main design methods that we used in our *Design & Development Process* to turn this initial idea into a prototype and then into a

demo: diagramming, templating, sketching, iterative design and playtesting for iterative design.

2.4.1. Diagramming gameplay design

As mentioned previously in the *Introduction*, diagramming, meaning the use of graphics to show the relationship between different elements, can be used to show the relationships between different elements of game design. Diagramming also is one of the many design tools that Dormans presents in *Engineering emergence: applied theory for game design* (2012) when talking about gameplay, level, and challenges design. Taylor et al. (2006) explain how diagrams can be used to describe game-flow, meaning the player's experience of the gameplay, while Byrne (2005) and Adams (2009) show how they can represent a level's structure. In our project, we used diagrams to describe: the player character abilities [*Figure 2.*], the overall game loop [*Figure 3.*] and the smaller loops of different sections of the demo [*Figure 4.*]. In the *Design & Development Process* chapter we explain how we used diagramming as part of our design process.

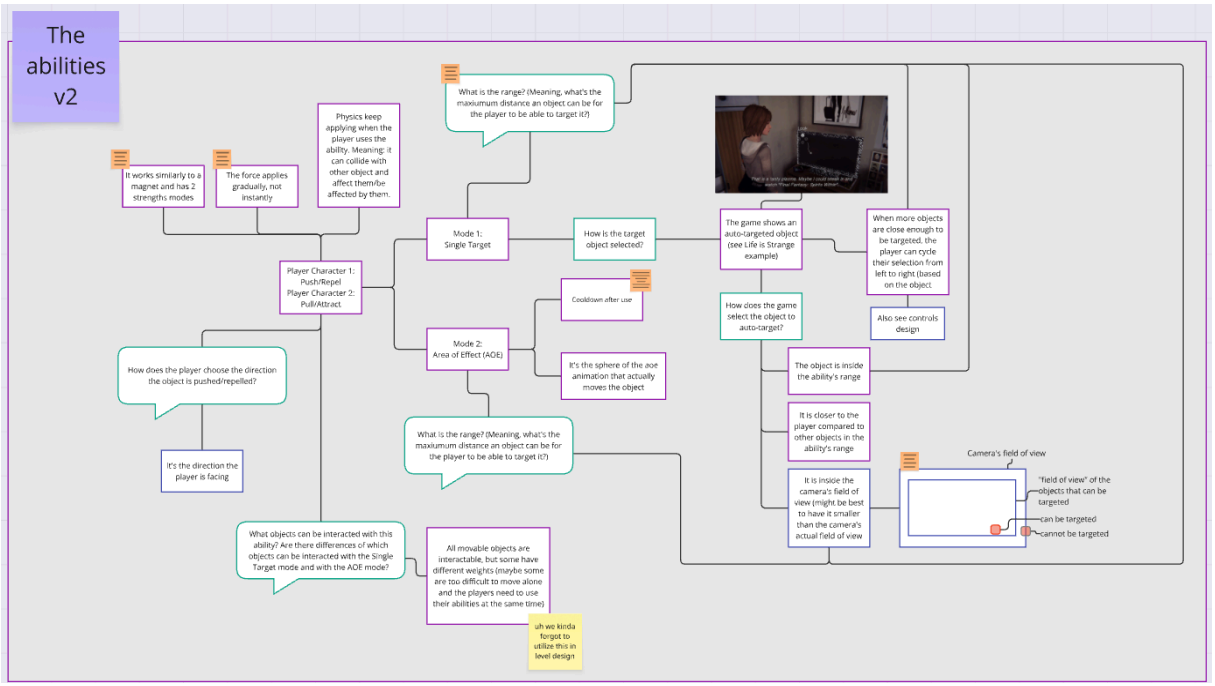


Figure 2. *Example of a diagram we used for the development process (diagram of the player character abilities [section 3.2.2.1.].*

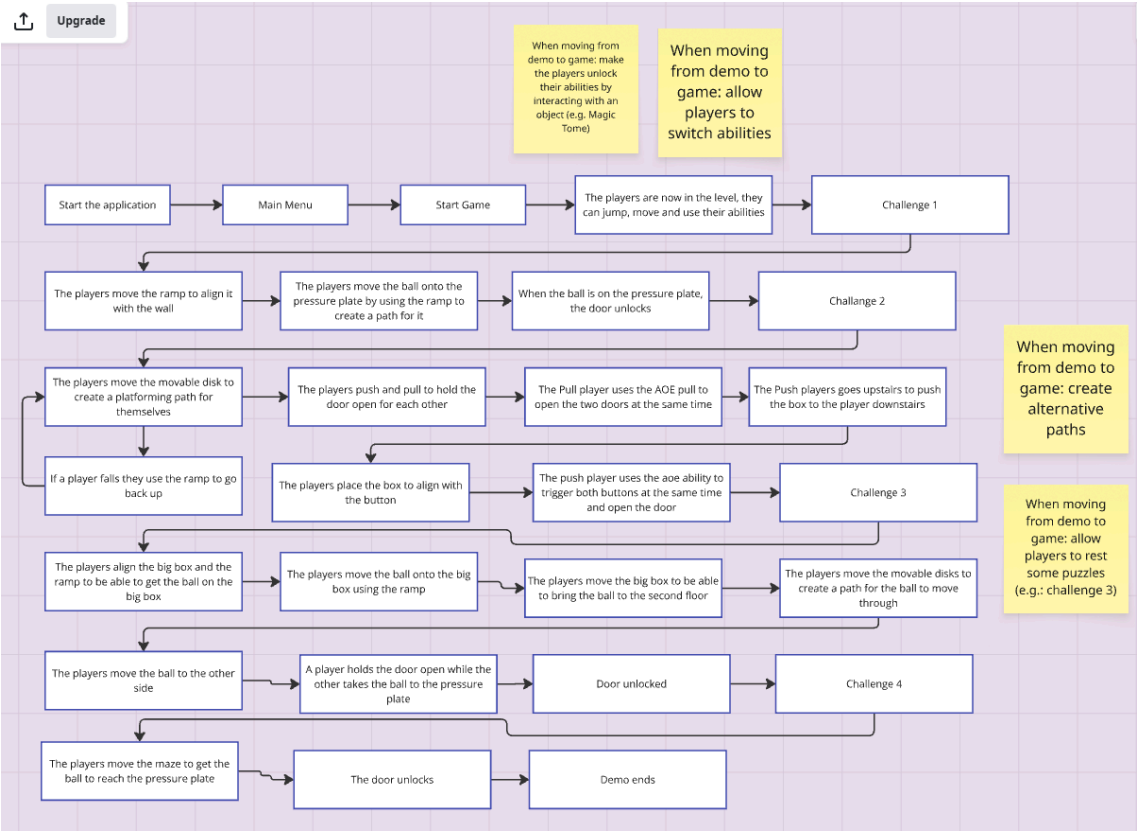


Figure 3. *Example of a diagram we used for the design process (diagram of the demo's gameloop [section 3.2.2.2.].*

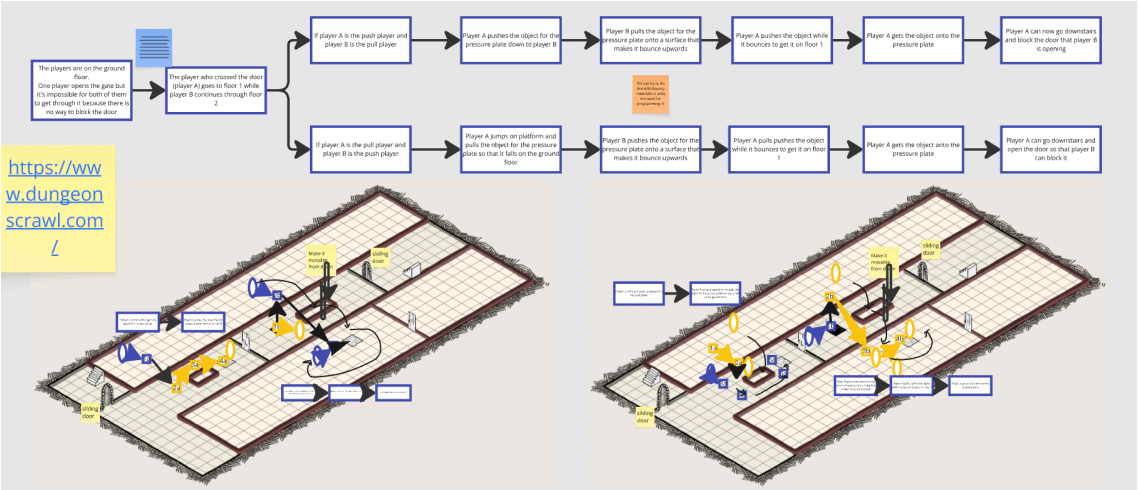


Figure 4. *Example of diagram used with sketching for level design (diagram and sketch of a challenge's design [section 3.2.3.1.].*

2.4.2. Iterative Design

Another set of Kultima's interviews is presented in *Developers' Perspectives on Iteration* (2015) which focuses on the role that game developers assign to iteration in the game development process. The paper concludes that iteration is viewed as fundamental to the process, from design to development, from problem-solving to polish. There are multiple iterative approaches, from iteration as elaboration and iteration as simplification to opportunistic iteration or omissive iteration. From her interviews with game designers and developers, Kultima explains that iteration is seen by professionals as a natural part of game development, from the progression from idea to full game to the process of innovation, as well as a way to structure the development process itself. Kultima presents the following frames of iteration:

1. *Iteration as elaboration.* One way of using iteration is to start from a core idea which never changes and is elaborated on by adding details that complement it. This use of iteration is also presented by Adams (2009) as iterative refinement that goes from prototype to full game by testing the implemented design, analyzing the result, iterating on the design to improve it and so on until the game is complete.
2. *Iteration as simplification.* On the other hand, iteration can be used to instead simplify the game by removing bit by bit ideas that are unnecessary or that there is no time to implement.
3. *Opportunistic iteration.* It is also possible to use iteration to find and explore new ideas. The game's development might start with one core idea, but along the way the direction can change, either because of needing to adapt to changes of circumstances or because by experimenting and testing out the original ideas a new design opportunity presents itself.
4. *Omissive iteration.* It can also happen that the focus on the core idea can prevent the developers from concentrating on refining the complementary ideas (Cuthbert, 2013). In this case, the exercise of creating an iteration without the core idea can allow the designers to focus on the rest of the game more efficiently.

2.4.2.1. Playtesting for iterative gameplay

As mentioned previously in the *Player-Centered Design* section, we have used playtesting throughout the prototyping and game development process to evaluate the results of our design choices and include players in our design process. We conducted different types of playtests, which served different functions:

- **In-house playtests for iterative design**
  - ➔ We tested the prototype among each other to check that the prototype was working as intended and adjusting various gameplay and level design elements during the testing sessions.

- **External playtests for iterative design: usability**
  - ➔ We tested the prototype with either two external playtesters or one external playtester and one designer to check if the prototype was working as intended and to evaluate its usability.

- **External playtests for iterative design: evaluating cooperative gameplay**
  - ➔ We tested the prototype with two external playtesters with the objective of evaluating how well our prototype and then our demo performed in enabling and encouraging cooperative play.

- **External playtest to gather data for our research question with the demo**
  - ➔ We tested the demo to gather the data needed to describe what the players' experience with our demo is, which is reported on in the *Players' Experience* chapter of this paper. We used the same methods previously adopted to evaluate cooperative gameplay, but this time we exclusively tested the demo with people who do not study games nor make or write games for a living.

The in-house playtests have been conducted with very narrow goals as part of our development tasks: checking bugs, finding speed and jump settings that feel nice to play with, adjusting the mass of objects and the strength of the player character abilities to make it feel natural and controllable, etc. This section however, focuses not on the in-house playtests, but rather the methods that we have used to conduct the playtests with external playtesters, meaning playtesters that are not part of our team.

In all our playtests with external playtesters our main method of data gathering has been observation, with a strictly structured approach when playtesting for usability & accessibility, and with a semi-structured approach when playtesting for evaluating cooperative gameplay (Sangin, 2018). For the usability & accessibility test we created the items for our observation spreadsheet by following the recommendations from Mirweis Sangin's *Observing the Player* (2018), while the items for our cooperative gameplay observation spreadsheet come from Aghabeigi's Cooperative Performance Metrics (2010).

As our demo is part of a thesis' project and none of us specializes as a user experience researcher, we also designed our playtesting protocols by referencing Julien Huguenin's *Running user tests with limited resources and experience* (2018). This meant determining strict goals for each testing session by restricting the size and number of focuses, to make it easier for us to analyze the data and to run the playtests (Huguenin, 2018). According to Huguenin, for tests aimed at researching the prototype's usability goals, it is sufficient to have five playtesters and use observation as the data gathering method, while for gathering data about the player experience it is ideal to have a sample of around twenty playtesters. As for the profile of the playtesters, Huguenin recommends having playtesters that are familiar with the genre

and support used to play the prototype/demo, and also adds that they should not make or talk about games for a living. For the playtesters done to inform our iterative design and development process we settled for accepting other MSc Games students as well, since otherwise we would not have been able to test at all, while for the final playtest of our demo we only gathered data from people who do not study games and do not make or talk about games for a living. The only other requirement that we had for our player profile was that they should be people who are interested in playing two-player cooperative games with friends and family.

2.4.2.1.1. External playtests for iterative design: usability

The objective of our first round of external playtests was to verify if the prototype was working as intended and to note down any usability and accessibility issues that we should address in future iterations. We listed each element of our prototype that we needed to check and followed a structured approach by making a spreadsheet [*Figure 5.*] that listed our playtest's objectives as questions to answer to by observing the playtesters (Sangin, 2018):

A	B	C
	Playtester 1	
Choose a name or nickname you want to be known with		Sonny
Playtest date		06/03/2025
	Yes/No	Other notes (e.g. level section, etc.)
Can each player use the Targeting for the Target Mode of their ability?	Yes	
Can each player use the Target mode of their ability?	Yes	yes but it stopped working for a moment
Can each player use the AOE mode of their ability?	Yes	
Can each player change the force strength of the Target mode?	Yes	
Can each player change the force strength of the AOE mode?	Yes	
When a Movable Object is placed on a Pressure Plate does linked Unlockable Door open?	Yes	
Can the Sliding Door be blocked open with a Movable Object?		they did not try
Is it impossible for both players to get past the Sliding Door without blocking it open?	No	
Can the players Push and Pull the Movable Platforms?	Yes	
Is it impossible for the players to Push or Pull the Movable Platform they are standing on?	No	
Can the players make a Movable Object bounce on a bouncy surface so that the other player can Push/Pull it in mid-air to get to the other side?		they didn't do it
Can the players jump?	Yes	
Is it possible for the players to reach with the jump the areas that are supposed to be able to reach with the jump and not in areas they are not supposed to?	No	

Figure 5. *Image showing part of our accessibility & usability spreadsheet. The sheet we used during playtests, each row has a column with a question in relation to the playtest, a yes/no column for the answer to the question, and a column where we can write notes in relation to each question.*

After this first round of playtest we made a report with suggestions on how to improve the prototype in the next iterations. We did these tests first, with the objective of not having usability issues affecting the later tests that we planned to iterate on the cooperative gameplay.

2.4.2.1.2. External playtests for iterative design: evaluating cooperative gameplay

In *Understanding and Evaluating Cooperative Video Games* (2010), Aghabeigi developed a method to evaluate if people are playing a videogame cooperatively with others, called Cooperative Performance Metrics (CPMs). Within this method, cooperative performance is defined as "a set of social and game play behaviors and interactions that happen while people play cooperatively with other people in a both physical and virtual shared environment" (Aghabeigi, 2010, p.53). It is a method based on observing events and behaviours that occur during playtests and assigning labels to them as shown in *Table 3.*:

Metric Name	Metric Description	Metric Application
Positive metric. *Laughter and excitement together* (label events happening in the same space only once per cause)	• The playtesters laugh at the same time to a specific game event. (ignore instances where only one player laughs without the others) • The playtesters express verbally that they are enjoying the game. • The playtesters show facial expressions and other nonverbal behaviors that clearly express happiness or excitement.	This metric implies the explicit fun has been raised by participants while playing games in a cooperative mode, so having high values for this metric, represents the high degree of enjoyment.
Positive metric.*Worked out strategies*	• The playtesters talk aloud about solving a shared challenge. • The playtesters divide the game zone to different parts in order to divide and conquer. • The playtesters navigate the world while consulting with each other. • The playtesters show pre-planned gameplay behaviour that emerges in similar cases.	This parameter explains the degree which players have cooperated together for proceeding in game play, and low values represent less cooperation than cases in which a high value for this parameter has been reported.
Positive or negative metric depending on the circumstance. *Helping each other* (researchers should label events under the Helping CPM when one player is helping the other and not when both are helping each other, this metric is also directly tied to difficulty and can be used to tune the difficulty of the game)	• The playtesters talked about controllers, and how one can use the game mechanics. • The playtesters told each other the correct way of passing a shared obstacle. • The playtesters saved and rescued the other player while they were failing.	This parameter shows the positive social atmosphere which a cooperative game can create, and mostly depends on what players do in physical space, for example helping each other using controllers, guiding each other, and etc.

Metric Name	Metric Description	Metric Application
Positive metric. *Global strategies*	• Playtesters take different roles during gameplay that complement each others' responsibilities and abilities	This parameter measures both social and game play aspect of role taking in cooperative games, as people play indifferent roles, they can have a different experience, so this parameter will try to consider the number of times the people changes their roles, which high values shows players are interested in different dimensions of game-play, and low values represents the minimum effort for looking at game from other perspective, anyway, this parameter depends on this fact that game offer different roles or not.
Negative metric. *Waited for each other*	• One playtester waits for the other to catch up	This metric can show both engagement and frustration, and it really depends on the skill gap between players who are playing the games, if the players are in similar level, then this value represents a positive social and game-play atmosphere which encourage players to support each other, otherwise it depicts a high frustration for one player who need to sacrifice all his time for another one to catch up.
Negative metric. *Got in each other's way*	• One playtester leads and the other lags behind. • One playtester wants to do an action and the other wants to take a different actions, and by taking these actions they interfere or hinder each other's goals	This value mostly presents a negative situation which can lead to frustration moments, having a high degree of conflicts can lead to frustration while having an average value can be acceptable and in some cases challenging that encourage players to decide with each other.

Table 3. *A table summarizing pages 60-63 from Aghabeigi (2010). Where we see cooperative performance metrics, their descriptions, and their applications.*

Aghabeigi's CPMs provide us both with a clear idea of what we need to observe and a clear idea of how to document our observations, which are key elements to consider when preparing to observe the player experience (Sangin, 2018). We decided to use a semi-structured approach: to record our observations we prepared a spreadsheet [*Figure 6.*] where we noted down the playtesters' play habits with games similar to ours and a yes/no answer with regards to the CPMs, but we also left spaces for additional notes and for a few follow-up questions to ask after the playtest.

	Playtest 2	
	Player A	Player B
Choose a name or nickname you want to be known with	Jake	Enrico
Playtest date	27/05/2025	27/05/2025
Experience with cooperative games (e.g. It Takes Two, Bread & Fred, Unravel 2, BOKURA, Biped, Portal 2, etc.)	At least once per year	At least once per week
Experience with 3D platforming games (e.g. It Takes Two, Contrast, etc.)	At least once per month	At least once per year
Experience with puzzle games (e.g. Portal, We Were Here series, It Takes Two, etc.)	At least once per month	At least once per month
The playtesters laugh at the same time to a specific game event. (ignore instances were only one player laughs without the others)	Yes	Yes
The playtesters express verbally that they are enjoying the game.	Yes	Yes
The playtesters show facial expressions and other nonverbal behavious that clearly express happiness or excitement	Yes	Yes
The playtesters talk aloud about solving a shared challenge	Yes	Yes
The playtesters navigate the world while consulting with each other	No	No
The playtesters show pre-planned gameplay behaviour that emerges in similar cases	Yes	Yes
The playtesters talked about controllers, and how one can use the game mechanics	No	No
The playtesters told each other the correct way of passing a shared obstacle	No	No
The playtesters helped the other player while they were failing	No	No
Playtesters take different roles during gameplay that complement each others' responsibilities and abilities	Yes	Yes
One playtester waits for the other to catch up	No	No
One playtester leads and the other lags behind	No	No
One playtester wants to do an action and the other wants to take a different actions, and by taking these actions they interfere or hinder each other's goals	No	No
Other notes	They skipped level 2, they carried the box with them xD, the puzzle on rails is the one where they had the most fun, if there was a way for them to control which player cinemachine prioritizes it would be nice	

Figure 6. *One of our CPM (Cooperative Performance Metrics) spreadsheets. In this spreadsheet there is a column of questions with regards to players frequency playing similar games to our demo and questions regarding their cooperation, as well as space at the bottom where additional information about the playtest can be written..*

Regardless of the notes taken, after the test we would ask the following questions: "Were there any specific moments where you remember working together to get past an obstacle?", "Were there any specific moments where you could have overcome an obstacle just as easily on your own?", "Were there any specific moments where it felt like playing with someone else was in the way of getting past an obstacle?", "Is there any particular part of the game that you liked?", "Is there any particular part of the game that you disliked?", "Do you have any feedback about how you think the game could be improved to be more fun to play together with another player (for you)?".

During each week in which we conducted one or more playtesting sessions, we made a report on the findings, highlighting what works well and what doesn't, and suggesting what to change in the next iteration based on the results and playtesters' feedback.

2.4.2.1.3. External playtest to gather data for our research question with the demo

After completing our demo we conducted a last set of playtesting sessions with external playtesters. The protocol followed was very similar to the one used for the playtests mentioned in section 2.4.2.1.2., but with some key differences:

- The playtesters were exclusively people who did not study games nor made or wrote about games for a living.
- We focused on gathering data on Aghabeigi's CPMs not with the objective of iterating on the demo's design, but to be able to answer our research question

> "How can cooperative game design principles shape game design processes, and how can the player experience reflect these design principles?".

The playtesting protocol as well as the results of the playtests are discussed in depth in the *Players Experiences* chapter of this paper.

2.4.2.2. Visual Design Framework

The visual design process used in this project utilized the ideation and iteration methods mentioned in this chapter. The team's constraints and the principles of cooperative design were used to guide the process of designing and implementing the visuals of the demo.

The constraints of the team meant that the visual design of the demo would have to be simple, while our principles demanded these visuals be clear and effective. Because of this, the visuals needed to be able to lead the eye of the viewer in order to help communicate the goals of the players in a simple and clear manner, while keeping the game space easy to understand and navigate. To achieve this, the elements of art were used to guide the production of the visuals. The elements of art are foundational aspects of visual art which can be used to lead the eye of viewers (*Elements of Art*, n.d.; Glatstein, 2019).

Colors can have impacts on people, which was something we had to keep in mind during production through color psychology. Color psychology refers to the impact of colors on the psyche. Certain colors incite physical reactions, such as red causing higher heart rates, while others have common associations, such as blue being associated with sadness. While color psychology was not a main guiding principle during production, the use of color was done in a way in which not to create emotional or physical reactions when there was no intention to do such a thing (Al-Ayash et al., 2016; Briki & Majed, 2019; Duan et al., 2018; von Goethe, 1840).

As one of the goals of the visual design was to help players understand their goals through the use of the visuals of the demo, visual communication was used to shape the types of designs which were created. Visual communication centers the simple idea of communicating concepts through the use of visuals, such as through the use of infographics or signs. For this demo, certain game assets were created to communicate things to players, and colors were used to create visual associations between different parts of puzzles (Günay, 2021; Vanichvasin, 2013).

As the implementation of the visuals was impacted by the constraints of the team, modularity was used in order to make the process of applying the visuals into the demo. Modular implementation is using various assets to create a unified whole, working from implementing macro level details to micro level ones (Bernstein, 2017; Ehnberg, 2017; Keinänen, 2024; Perry, 2002; Statham et al., 2022).

2.5. Design Framework Overview

In conclusion, the first step of our design & development has been coming up with an initial idea as our starting point (Kultima, 2010). In order to reach this initial idea we defined the game design principles of our demo (Aghabeigi, 2010; Jonassen, 2017; Kultima & Sandovar, 2019; Sykes & Federoff, 2006), we discussed and analyzed similar games to identify pairs of game mechanics (Bernard, 2022; Kultima, 2010), and we used brainstorming to come up with pairs of abilities for two player characters (Kultima, 2010; Pranes, 1961; Sowrey, 1990), as illustrated in *Figure 7* and *Figure 8*.

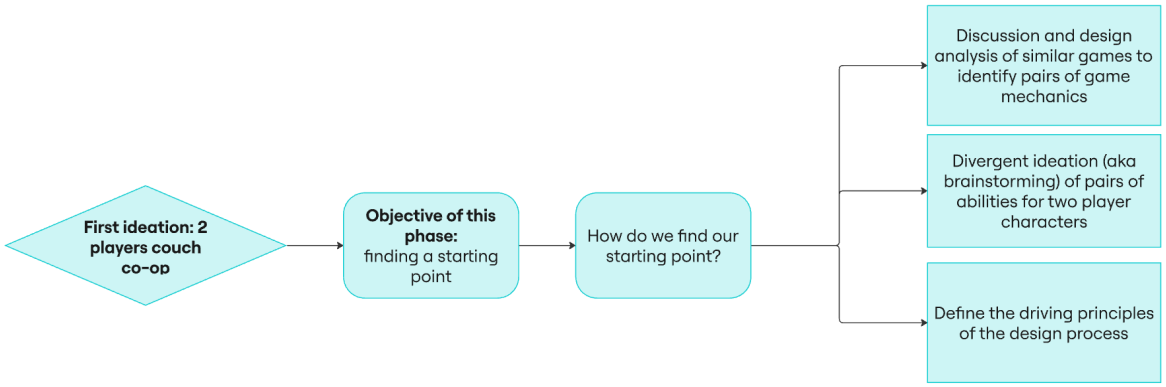


Figure 7. *Diagram used during ideation. Explains the process of finding a starting point to design a demo around. It shows the process of starting and states three different ways to approach it, as seen on the right going from top to bottom, Discussion and analysis of similar games, Divergent ideation (brainstorming), and defining the principles of the design process.*

From the analysis of similar games and the divergent ideation we made a list of pairs of abilities for the player characters. During this initial step the only criteria used to judge the ideas brainstormed has been to consider whether or not these abilities seemed complementary to us: as seen in *Figure 9*, if they were not complementary they would not be included in the list. The game design principles, as illustrated in *Figure 10* that we set for this project and the constraints that we have identified started coming into play to whittle down ideas from this starting list: we considered which ideas would be more suitable to achieving our goals.

Once we narrowed down the player characters abilities to one pair we proceeded to start designing the player characters' gameplay, the game loop, level design and the visual representation of the player characters and environment, as shown in *Figure 11*. We used diagramming, sketching and templating to explain the design and we iterated on it both before and during the prototyping phase (Kultima, 2015).

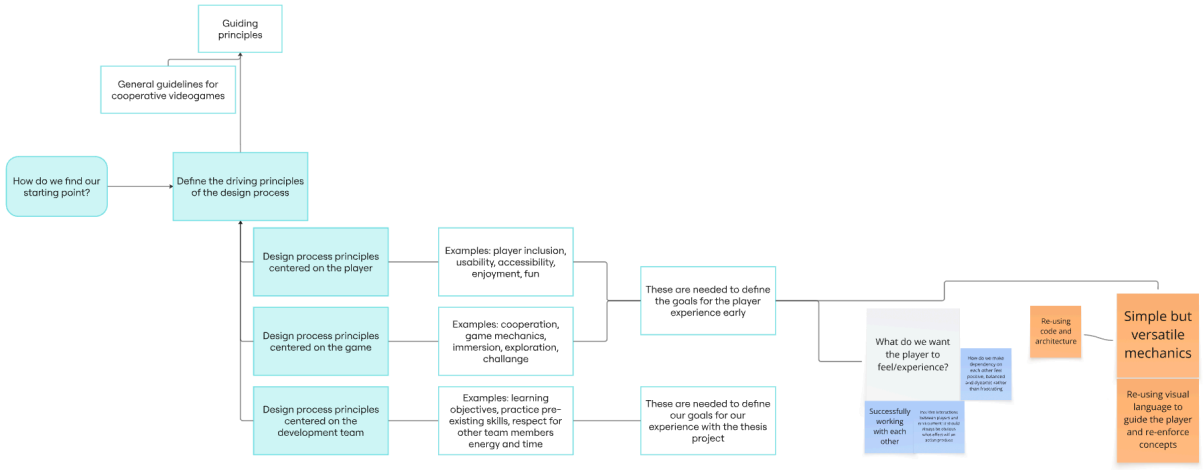


Figure 8. *Diagram used when defining guiding design principles. Shows the prerequisite goals and limitations that were used when defining the principles, from technical limitations ("Re-using code and architecture") to player experience goals ("Successfully working with each other").*

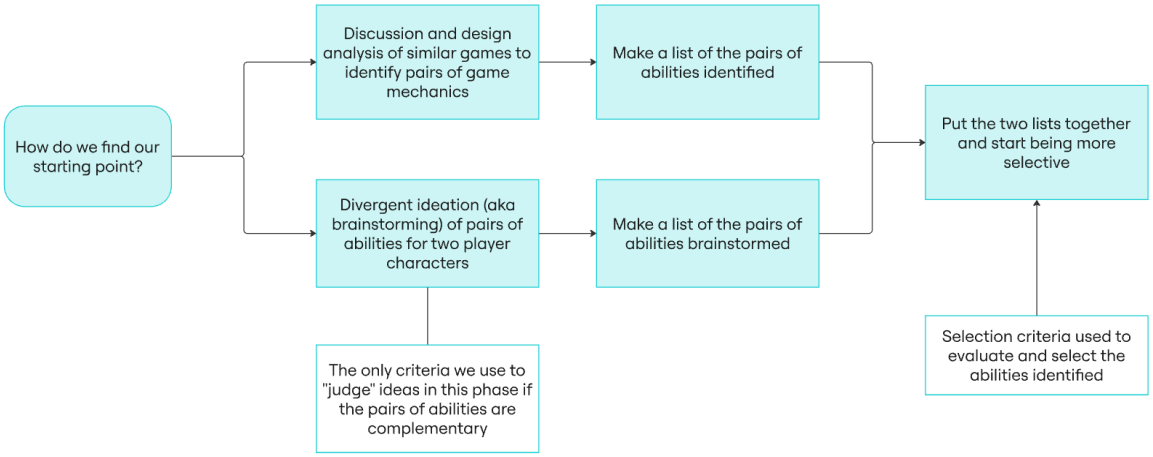


Figure 9. *Diagram that illustrates how we split the ideation of player abilities and then combined them again. The ideation was split into analysing similar games and making a list from which to draw inspiration from, and a divergent ideation session where we made up abilities that went into another list. These lists were then combined.*

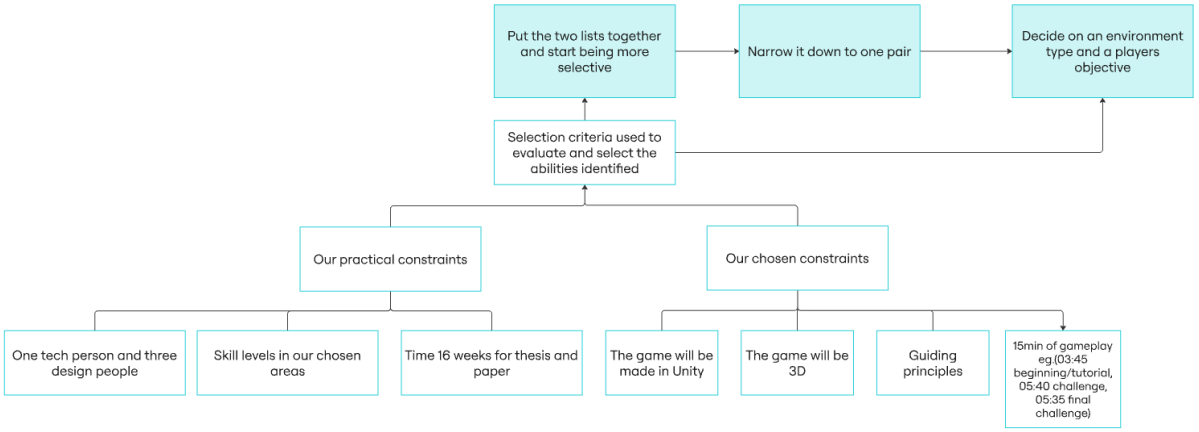


Figure 10. *Diagram that expands on Figure 9. Here we start with the combined list of abilities and use our practical and chosen constraints to narrow it down to eventually one pair of abilities.*

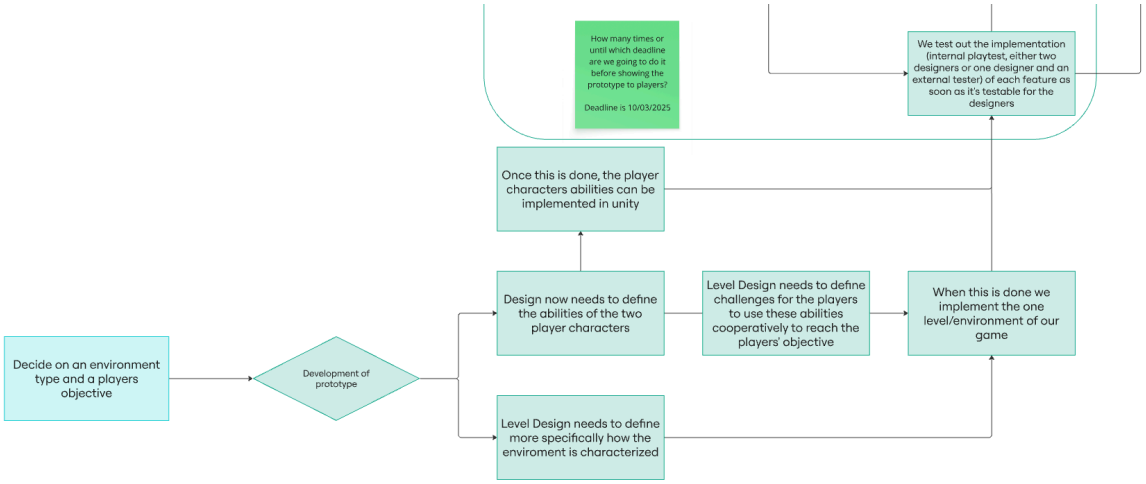


Figure 11. *Diagram showing how we progressed from early ideation to implementation of a prototype. After deciding on the environment and player abilities the tasks split up into defining and implementing the players abilities, and defining the environment and designing challenges that incorporate the environment and player abilities.*

As illustrated in *Figure 12* and *Figure 13*, we used in-house playtesting as a design tool for iteration, to fine-tune various gameplay elements and to catch bugs and other issues. Once the game's features were in working condition within a playable prototype we tested them with external playtesters, first for usability and then to gather data on the effectiveness of our design in relation to cooperative gameplay, as shown in and *Figure 14* (Aghabeigi, 2010; Huguenin, 2018; Sangin, 2018).

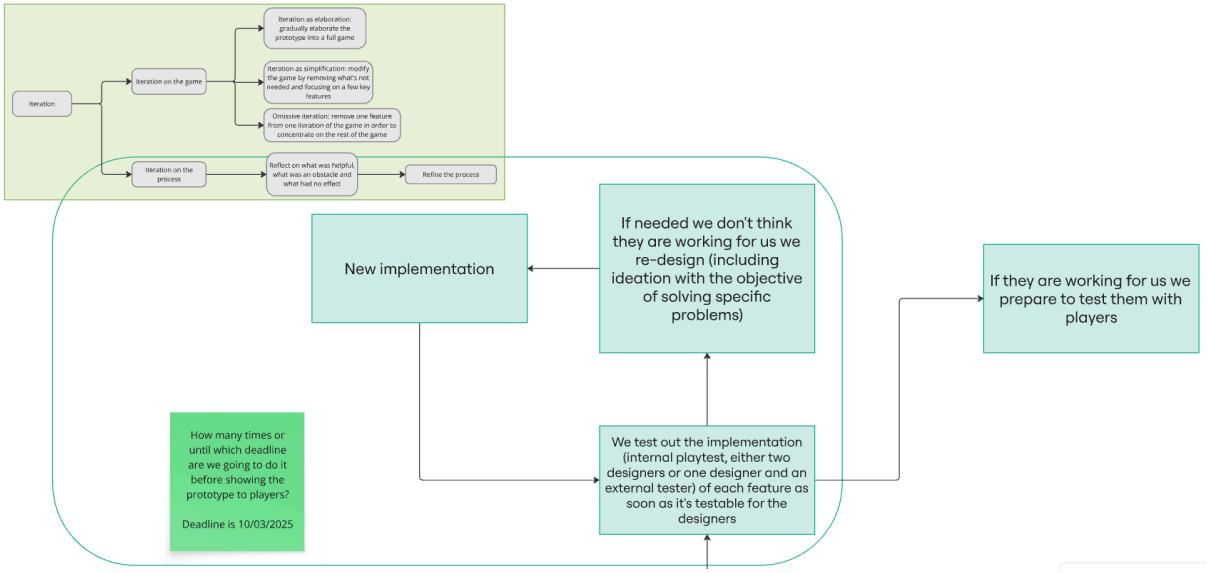


Figure 12. *A diagram explains our testing process. When a new implementation has been made we test internally, if the test goes well we go on to testing with external playtesters. If the implementation does not go well we re-evaluate and re-design until a new implementation has been made. As an add-on to this diagram we have the diagram in Figure 13.*

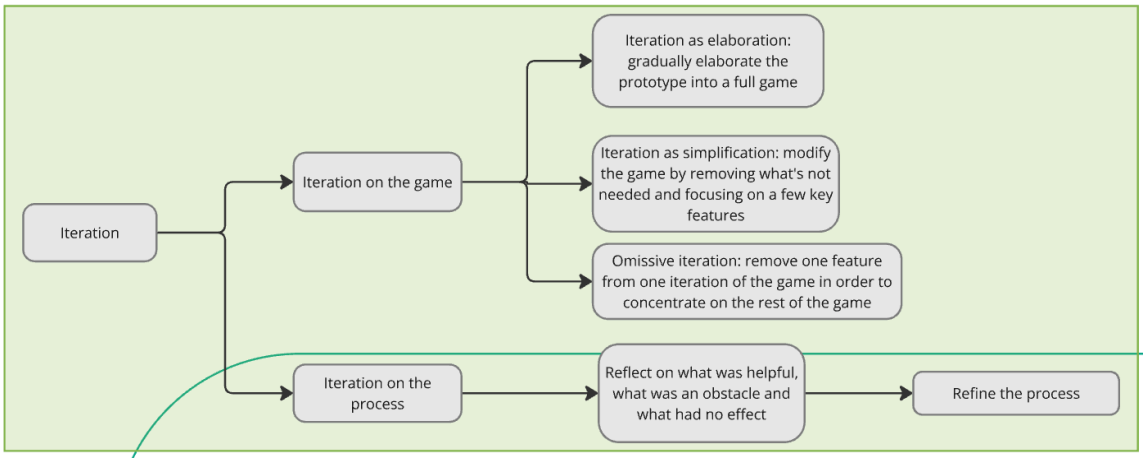


Figure 13. *Diagram that explains our approach to iteration. We have two iteration methods, the first one is iteration on the game via; iteration as elaboration, iteration as simplification, and omissive iteration. The second is iteration on the process via; reflecting on the process, and refining the process.*

After the prototyping phase we took the time to reflect both individually and in pairs about the methods and process we used, what about it worked well for us and what didn't with the objective of using these insights to improve our design & development process for the demo, as illustrated in *Figure 15*. We also took stock of the status of the prototype by re-describing them, noting down which changes would be both useful and within scope for the demo and which ones would need to be put aside for future iterations.

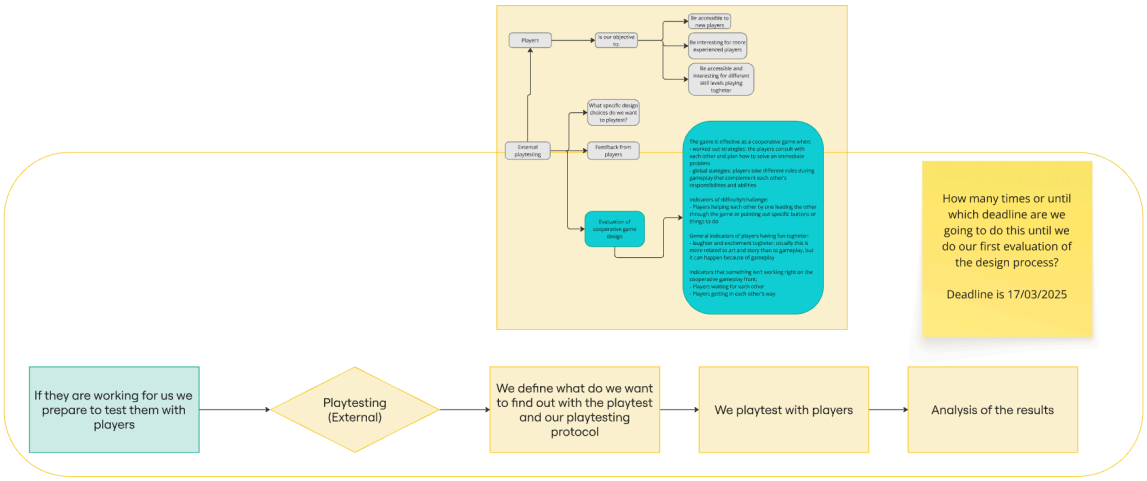


Figure 14. *Diagram visualizing the external playtesting process. We define the current playtests playtesting protocol and goal, then playtest while taking notes, and analyse the resulting data (More on external playtesting in Chapter 4.). As an add-on for this Diagram we have another diagram that has further details on how to define the playtesting protocol as an example: What are we looking for from the playtesters?, What design choices or mechanics are we testing?, and reminders to keep our cooperative game design principles in mind.*

Figure 15. *Diagram illustrating the process from external playtests to demo implementation. If the external playtest results are positive enough for us we reflect on our processes, make changes to the processes, and then use the new processes to expand on the prototype in an effort to make the demo.*

3. Design & Development Process

This chapter goes over how we put into practice the use of game design principles, with a focus on cooperative game design principles, and of the design methods presented in the *Design Framework* chapter.

3.1. Cooperative Game Design Principles in practice

In the *Game Design Principles* section of the *Design Framework* chapter, we explained how we identified and defined the game design principles of our demo, among which have included various common cooperative game design patterns. This section explains how we used them to guide our design and development process.

3.1.2. The role of cooperative game design principles during the gameplay ideation phase

During our gameplay ideation phase, which is described more in depth in the *Ideation techniques* section of this chapter, we mainly used cooperative game design principles to guide our divergent ideation, also known as brainstorming sessions (Kultima, 2010), our analysis of similar games, and our convergent ideation sessions.

The focus of our gameplay ideation phase has been mainly on the player characters'[5] abilities and the types of challenges that our characters might encounter. The reason of this focus can be traced back to the following game design principles that we set for our demo:

- ***Player centred game design principles.*** The collaboration should feel satisfying for both players together.
- ***Game design principles centred on the player.*** How do we make dependency on each other feel positive, balanced and dynamic rather than frustrating.
- ***Game centred game design principles.*** Gameplay should support cooperative play.
    - ***Cooperative game design principles.*** Player character abilities should be asymmetric and equally fun for both players. We want the player characters' abilities to be complementary, allowing for interdependent roles (Aghabeigi, 2010; Jonassen, 2017).
- ***Game design principles centred on the team.*** We want to learn how to design gameplay and game mechanics for local two-player cooperative games.

For this reason, when brainstorming ideas for the player character abilities and analyzing similar games we focused on coming up with and identifying pairs of

[5] ***Player Characters.*** The two characters that the players can control in our demo, each player can control only one character.

complementary abilities. While ideating on the challenges, Laura's (Gameplay&Level Designer) brainstorming sessions and analysis focused on coming up with and identifying types of challenges that could require the players to work together.

The brainstorming sessions and analysis of similar games allowed us to put together a list of pairs of abilities and a list of possible challenges for the players. Laura (Gameplay&Level Designer) started to evaluate which ideas to keep and discuss with Hanna (Art Direction), Hallur (Tech Lead) and Mikkel (Gameplay&Level Designer). The selection criteria for which ideas to keep and which ones to discard was based on the demo's game design principles.

For the player character abilities, the questions that Laura (Gameplay&Level Designer) posed were:

- ***Cooperative game design principle.*** Are the player characters' abilities complementary? (Aghabeigi, 2010; Jonassen, 2017)
- ***Cooperative game design principle.*** Are there synergies between the player characters' abilities? (Aghabeigi, 2010)
- ***Cooperative game design principle.*** Can the player character abilities be used on the other player? (Aghabeigi, 2010; Jonassen, 2017)
- ***Cooperative game design principle.*** Do the player characters' abilities allow for asymmetric gameplay? Do they allow taking on specialized interdependent roles? Do they allow players to interact with the same object in different ways? (Aghabeigi, 2010; Jonassen, 2017)
- ***Game design principle centred on the game.*** Are the player characters' abilities versatile with regard to how they can be used to interact with the level?

For the challenges, the questions instead were:

- ***Cooperative game design principle.*** Does the challenge allow the players to assume specialized and interdependent roles? (Aghabeigi, 2010; Jonassen, 2017)
- ***Cooperative game design principle.*** Does the challenge give a shared goal or a shared puzzle for the players to overcome/solve together? (Aghabeigi, 2010)
- ***Cooperative game design principle.*** Do the players interact with the same object? (Aghabeigi, 2010)
- ***Cooperative game design principle.*** Are there limited resources to be used in cooperation? (Aghabeigi, 2010)
- ***Cooperative game design principle.*** Are there synergies between the players' goals? (Aghabeigi, 2010)

To each question, Laura (Gameplay&Level Designer) connected which abilities and challenges could be the answer to it. Then they evaluated the pairs of abilities and the challenges together to answer the question:

- ***Game design principle centred on the game.*** Does the challenge integrate with any of the game mechanics brainstormed?

They then paired with each challenge the abilities that could be compatible with it.

This process allowed them to reduce the ideas to a smaller number, which then Laura (Gameplay&Level Designer) discussed first with Hanna (Art Direction) to talk about how these mechanics and challenges could look like, and then with Hallur (Tech Lead) and Mikkel (Gameplay&Level Designer) to evaluate them based on how easily they could be implemented, thus focusing on another game design principle:

- ***Game design principle centred on the game.*** Are these game mechanics simple to implement?

3.1.3. The role of cooperative game design principles during the prototyping phase

As a follow-up to the gameplay ideation phase, where we made the foundation for our player characters and our challenges by using our cooperative game design principles, the next step was to begin building our core mechanics. In this chapter, we will describe how we applied our principles of complementarity, interdependence, shared goals, and accessibility in the implementation of some of our games' mechanics during the prototyping phase.

We wanted to create a cooperative experience where both players feel like they contribute equally and meaningfully. This means that we had to make player abilities that feel different and that require collaboration. We decided on simple yet versatile abilities, namely Push & Pull. These mechanics are what the challenges were designed around.

By making and iterating on these mechanics early we managed to evaluate whether the design decisions we made were supported by our chosen game design principles. Through iteration and testing, we tested how mechanics could influence player interdependence, how physics-based movement affected usability, and how the layout of our levels affected cooperation among players. The prototyping phase therefore became crucial and essential in going from abstract design goals to playable, testable systems.

In the following sections, we will discuss how we made our core mechanics, what challenges we encountered along the way, and how we incorporated and used cooperative game design principles to evaluate and improve our systems.

3.1.3.1. Applying Cooperative Game Design Principles

During the prototyping phase, we used our cooperative game design principles to make our mechanics, focusing on implementing the player's core abilities that emerged from the ideation phase. The core abilities we decided on were Pull & Push; we gave one player the ability to attract objects (pull) and the other player the ability to repel them (Push). We designed these abilities to be simple and easy to understand while not being restrictive, enabling varied interactions. The game design principles we can see reflected in these decisions as mentioned in section 2.1.2.1 are:

- *Player character abilities should be asymmetric and equally fun for both players.*
- *Game mechanics need to be simple to implement while allowing varied experiences.*
- *The experience should be enjoyable by both players even if they have different videogame literacy levels.*

Complementarity and Synergy. Giving each player one ability gave them distinct roles in puzzle-solving and challenges. On the other hand, as we were implementing early iterations, we realized quickly that complementarity did not automatically lead to interdependence. In the initial tests, the Pull ability was more intuitive and easier to control than the Push ability; this made the Pull player feel more impactful than the Push player. To address this problem and stay true to our design principle, "*The collaboration should feel satisfying for both players together*" [section 2.1.2.1] we made two design changes:

1. **Redesigning obstacles**: We redesigned the puzzles and repositioned objects to give the Push ability a more precise and impactful role in solving challenges.
2. **Tuning the Abilities range**: We implemented a minimum and maximum distance requirement for using the Push and Pull abilities. This limited both abilities, cutting down on one ability being dominant and thus improving the balance between them.

We did identify a more advanced improvement: making a targeting system for the push ability that could match the accuracy of the Pull ability. However, we didn't have the resources to implement this, so it remains a possible addition to the game.

Technical Considerations. We explored two approaches to the abilities: a custom movement system that is scripted and guides objects manually or Unity's built-in physics engine, which applies forces to objects through that. We settled on the physics-based solution as it would provide a more freeform environment that is more intuitive and natural for the players. This decision was guided by the principle of "*Intuitive interactions between players and environment: it should always be obvious what effect an action will produce*" [section 2.1.2.1]. On the other hand, the physics system also made certain things more volatile because we have less control, requiring us to adjust the object's mass and drag and apply differing forces throughout the development for consistent behavior.

Mechanics in Practice. The first interactable object we made was the sliding door[6]: an object that has a sliding door that has a constant force applied to keep it closed and is opened by the player's ability when they apply a strong enough contradicting force. This object is a simple but effective use of our cooperative mechanics: one player opens the door (push/pull) while the other goes through. Although the mechanic was basic, the door demonstrated some of our cooperative game design principles mentioned in section 2.1.2.1:

- *Intuitive interactions between players and environment: it should always be obvious what effect an action will produce.*
- *Gameplay should support cooperative play.*

As we progressed, we added more mechanics that encouraged interaction, like mazes and puzzles that could only be completed if the players worked together. We worked to ensure that no obstacle could be cleared by any single player, maintaining interdependence and avoiding the problem of one player carrying[7] the other player.

Design Accessibility and Inclusivity: concise controls. In our game, we kept the player's abilities limited to one for each player and simple so that they'd use as few inputs as possible, which would make them faster to pick up regardless of the player's skill level. Through playtesting, we checked for the usability of the player characters and the understandability of the interactions with the level, as well as for enjoyment of the experience with players of different skill levels.

Designing for a range of skill levels. The difficulty level is also set low by default, so that it can be played even by first-time videogame players, and it is not so complex that adjusting rules and win conditions is necessary. However, since the two players might want to switch abilities to play different roles, we implemented the option to agree together to switch which player has which ability.

Shared Puzzles. The challenges are designed to be overcome by using the two-player characters' abilities in collaboration. Collaborative behavior is rewarded by succeeding in progressing with the demo and by positive interactions with the other person while playing. While there is a default way to overcome the challenges, we chose not to prevent some more out-of-the-box approaches that still require players to play and collaborate together. The primary pro-social player interaction between our two players is contributing to their character's ability to overcome obstacles on the way to the goal. We did not really include any ability that can be used on the other player in our game, but having emotes would however be a good element of polish to have in the future.

Camera Constraints and Design Impact. As noted in the *Design Framework* chapter, there are three main Camera setting design choices that have been proven successful when developing the camera for cooperative games: “split screen horizontally or

[6] ***Sliding Door.*** A door of which the handle can be Pulled or Pushed open, it slides back to its initial position if it stops being Pushed/Pulled open.
[7] **Carrying.** In this context “carrying” refers to one player always being in the lead while the other contributes less or is more inactive than active.

vertically, one character in focus, all characters are in focus (the screen doesn't move unless all characters are near each other)". In our case, we have opted for a shared screen with all characters in focus from the angle [*Figure 16.*]. For our level design, this has meant two things: firstly, the level should develop horizontally along the X axis, as this angle platforming and moving objects that are far away along the z axis would be less legible for the players, and secondly, the spaces should be small, or the camera will focus on only one player character if they split up.

Figure 16. *Snapshot of the demo showing the camera angle we use for the demo.*

3.1.3.2. Challenges and Trade-Offs

In this chapter, we will review some of the challenges and trade-offs we made during our prototype phase. We will cover cases like Unity's inbuilt physics and collider makeup and how that was an issue we had to overcome, how simplicity and variety did not necessarily go hand in hand all the time, and when a game design principle made a decision or implementation difficult.

3.1.3.2.1. Technical limitations

We encountered technical limitations when implementing a feature we call floating platforms/discs[8]. In this case, the limitation is that the platform itself is a circular disc and, therefore, needs a convex mesh collider[9]. While this in and of itself was not a problem, we encountered the problem when we realized that the rigid body[10] on the platform wouldn't work. Hallur (programmer) found out through researching the Unity forum and trying his hand at bug fixing, that Unity Does not support having convex colliders and rigid bodies on the same object.

This realization was a big problem as the entire point of this feature was to make it as simple as possible and to have players be able to interact with its rigid body using their abilities. The way we fixed this was to create an object[11] that is a child object[12] of the platform; we would then remove the rigid body from the platform and add a rigid body to the child object. We would then add a script[13] on the child object that made it drag the platform with it when it was moved using the player's abilities. This workaround made the platform work as expected. Later on, we realized that players could affect the platform while standing on it and, that way, push themselves on the platform without collaborating. This scenario went against our principles: "*Gameplay should support cooperative play*" [section 2.1.2.1], so we made changes so that when a player is on the platform, it cannot be moved by either player.

While all of these changes made the platforms behave as we wanted, they also made implementing a "simple" feature much more complicated for all developers to work with. Thus, we had to compromise on our principle: "*Game mechanics need to be simple to implement while allowing varied experiences*" [section 2.1.2.1], as this "simple" feature is not as versatile as we originally wanted it to be.

3.1.3.2.2. Simplicity and variety

One of the main things we aimed for during prototyping was keeping mechanics simple but flexible. The idea was to create features that didn't do too much on the surface but still gave players plenty of room to play around and figure things out. We wanted players to naturally understand how things worked and what they should do without needing instructions or tutorials based on our principle: "*Intuitive interactions between players and environment: it should always be obvious what effect an action*

[8] **Floating platform/disc.** A floating platform is a movable object, meaning an object that the players can push/pull with their abilities, in the shape of a disc. In the demo it is used, for example, to create a platforming path for the players or to make a path to move a spherical movable object from point A to point B.

[9] A convex mesh is required by the Unity physics engine so that a mesh collider has a non-zero volume (*MeshCollider.Convex*, n.d.)

[10] Adding a Rigidbody component to an object will put its motion under the control of Unity's physics engine (*Rigidbody*, n.d.).

[11] UnityEngine.Object is the base class of all built-in Unity objects (*Object*, n.d.).

[12] A dependent object used by another object, the parent object.

[13] A piece of code that allows you to create your own Components, trigger game events, modify Component properties over time and respond to user input in any way you like (*Creating Scripts*, n.d.).

will produce" [section 2.1.2.1]. But getting that balance right wasn't easy. Through weekly playtests, we saw that some of our early designs—especially the player's main ability—were too much. There were a lot of visual effects and extra functions packed into it, and instead of helping, it just confused players. So, we ended up simplifying it a lot. We slowly stripped it down until only about half of the player's main ability was left [*Figure 17.*, *Figure 18.* and *Figure 19.*], but it played much better that way.

Figure 17. *Image showing the particles that indicate the AOE ability is in use in the demo. the particles spawn and move away from or towards the player depending on if the ability is push or pull.*

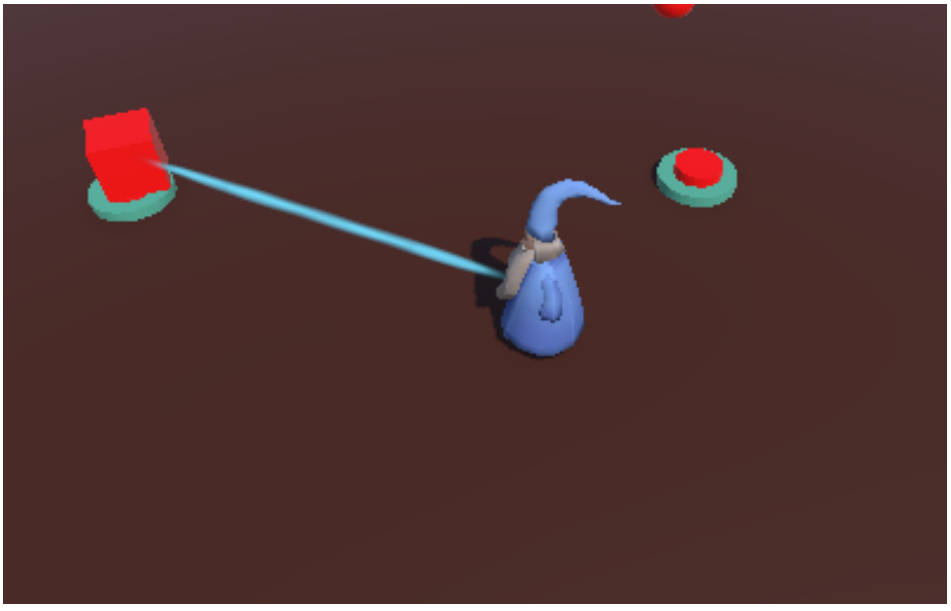


Figure 18. *Image showing the line indicator for the single target ability in the demo.*

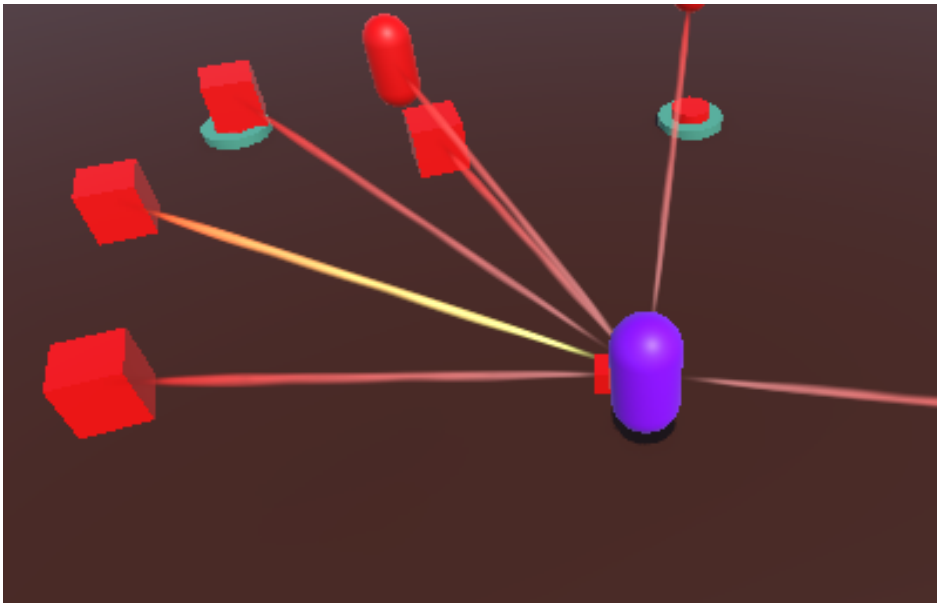


Figure 19. *The old version where the AOE showed all applicable objects and the lines to them as well as highlighting the single target line.*

Another thing to mention was how we simplified three other features, blinking buttons, floating platforms and large object movement. These changes were, to some extent, technical, but mostly, they were design decisions to simplify interactions between the game and the players.

The idea behind the timed buttons was to add tension and push players to cooperate under pressure. The buttons would blink after one was pressed, which looked fine visually. But behind the scenes, each one used its coroutine[14] to handle the timing, adding a lot of extra processing. In the end, players either felt like the blinking was distressing to the eyes or barely noticed the blinking and did not feel the time pressure, so it didn't add much to the experience. It didn't fit with our goal of keeping things clear and easy to read, both for the players and the system. Therefore, a big part of our process was learning when to cut back or drop ideas completely—even if they have sentimental value to the team or in other words *'kill our darlings'*[15] (Mitchell, 2024)—to make the game smoother and easier to understand.

Regarding the floating platforms, there were originally ideas of letting them bounce objects and players off them. This idea included some verticality to the game, but technically, there was no easy and fast way to do it. For that reason, the bouncy platforms idea was discarded as it was not crucial or inherently tied to any of our core game design principles, so we evaluated that the time to make them bouncy manually was not worth the effort. Another thing to mention regarding the floating platforms was

[14] A coroutine is like a function that has the ability to pause execution and return control to Unity but then to continue where it left off on the following frame (*Coroutines*, n.d.).
[15] To *kill your darlings* is a common phrase used in literature to mean "when you decide to get rid of an unnecessary storyline, character, or sentences in a piece of creative writing". In this context it means to cut out or replace a feature that has sentimental value.

the original idea to have multiple platforms that the players would have to collaborate to move around to make a bridge to the other side of a ravine [*Figure 20.*]. In the end, by playtesting, we found out that in this case, it was usually one player dominating and there was little collaboration, so we redesigned the obstacle so that there was just one floating platform and one pillar that the players would need to move the platform around. This made it so that the obstacle was only overcome by the two players collaborating and communicating their intentions based on our principles: "*The collaboration should feel satisfying for both players together.*" and "*Gameplay should support cooperative play*" [section 2.2.2.1].

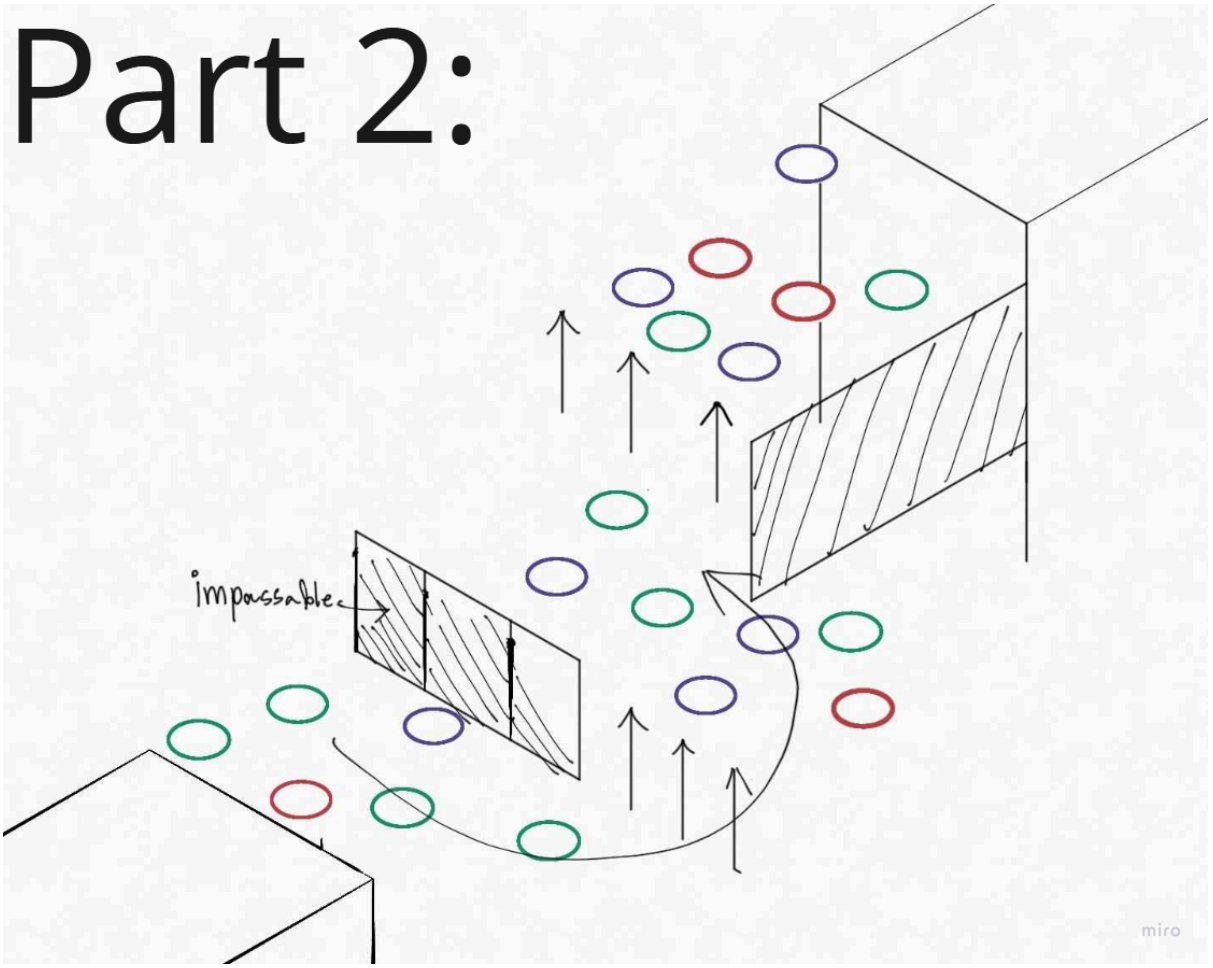


Figure 20. *Image showing the original idea to have multiple platforms that players have to manipulate to make a bridge over a ravine.*

Another example is that moving big objects with the abilities was very unintuitive for most players. So we decided to put all objects we qualified as "large" on tracks. These tracks were mostly visual guides to give the players hints at the intended solution to an obstacle. We also locked the movement of such objects on the axis that did not follow the rails to indicate the direction they should go based on our principle: "*Intuitive interactions between players and environment: it should always be obvious what effect an action will produce*" [section 2.1.2.1].

3.1.3.3. Communication and Cross-Disciplinary Collaboration

Throughout development, communication within our team was a constant learning point, with moments of strong alignment and inevitable friction. We established the game design principle *"Direct, honest, calm and respectful communication: don't hesitate to say when you're encountering problems, need help or when something another team member's work has flaws that should be worked on."* in section 2.1.2.1, which became a cornerstone of our collaborative process. This principle, in particular, helped us move quickly through the prototyping phase, allowing team members from different disciplines—design, programming, art, and production—to voice concerns, propose changes, and resolve issues without politeness slowing things down. While this occasionally led to tense discussions, especially when feedback touched on someone's core contribution, it ultimately fostered a culture of mutual respect where feedback was expected, not feared. That said, not all communication was perfect; we sometimes struggled with timing, bringing up changes too late or not with enough clarity, especially when technical and non-technical perspectives clashed. However, the open atmosphere allowed us to identify and improve these gaps over time. By the end of the project, our ability to give and receive honest feedback across disciplines helped us work more efficiently and ensured that decisions were better informed by multiple perspectives.

3.2. Design Methods in practice

3.2.1. Ideation techniques

Usually, as Kultima (2010) observes, for designers the difficulty is not finding ideas, but finding workable ideas is difficult. As any other skill it is improved by experience and consequently, the more experienced a designer is the more likely it is for the ideated ideas to become workable ideas (Amabile, 1990; Baer, 1994; Clapham, 2003; Harkins & Macrosson, 1990; Kultima, 2010). As a team we are not completely inexperienced, Laura for example has four years of working on group projects in learning settings and game jams. However, contrary to previous experiences, this time we have used our cooperative game design principles as guidelines to evaluate our ideas. Ideas can also be evaluated through analysis, especially if these ideas are based on other games (Fullerton, 2024; Kultima, 2010).

For games, it's often more important to define the key game mechanics first than the game's thematic aspects, because while themes are important they are more easily changed than mechanics and systems (Kultima, 2010). This is true for our project too as the main objective of our ideation process has been to settle on a pair of complementary game mechanics for the player characters and have a list of challenge types that would work well with these mechanics.

The ideation process of our prototype's game mechanics went like this:

1. When forming the team and choosing our thesis topic we had an informal group divergent ideation about pairs of complementary game mechanics and did together a first informal analysis of similar games to identify the features that made them cooperative games. This is the conversation from which we got our self-imposed constraints of making a 3D two-players local cooperative game. It also helped us to start to define some of our design principles, such as having complementary game mechanics, simple but versatile mechanics and intuitive interactions with the environment.
2. After identifying and defining our constraints and game design principles as explained in the Design Framework chapter, it was time to start a more formal ideation. Laura (Gameplay&Level Designer) did the brainstorming alone by adding more ideas to the one brainstormed and analyzed before the project period began. They did so by doing a solitary divergent ideation session about the game mechanics with the objective of having pairs of mechanics, and a game analysis session where they identified mechanics from similar games. They followed the same process to ideate on the possible challenges. Similar to what reported by other game designers in Kultima's paper (2010), ideating alone felt more difficult than ideating by brainstorming with a group: when ideating with a group Laura's self-criticism is less strong because the ideas are not just theirs, they're the group's idea, they don't have to prove the ideas worth to other people. However, the ideation session that the team did beforehand to decide on the type of game helped a lot to have a clear direction and goals for the ideation, which prevented Laura from getting stuck.
3. As explained in the Cooperative Game Design Principles in practice section of this chapter, Laura then evaluated the ideas they had ideated based on "how do these ideas relate to our design process principles?" and "how well do these pairs of game mechanics and the challenges work with each other?". Having the design principles and our practical constraints clearly defined was very helpful to guide the evaluation phase. Another helpful tool to think about how these abilities could support cooperative gameplay (Aghabeigi, 2010; Jonassen, 2017).
4. Then Laura consulted Hanna (Art Direction) first to select the more interesting ideas and bounce these ideas on her. After this selection was done, Laura met with Hallur (Tech Lead) and Mikkel (Gameplay&Level Designer) to evaluate the ideas based on workability and also on what inspired us to actually start designing. This allowed us to begin the discussions about how to implement the Push and Pull mechanics, what kinds of challenges we could have, controls, cameras, etc.

The objective of having a starting idea that helped us begin the design and development process had thus been achieved. The designers were able to start the design work and the developer was able to start working on a proof of concept.

3.2.1.1. Seeking inspiration from similar games

In *Local Multiplayer Games* (2022), Bernard describes the process of creating a local multiplayer game. Bernard's process begins with a concept document, describing the initial concept of the game, which was then used to select similar games to analyze for a review of the state of the art. Based on the state of the art review, Bernard then updated the concept document and proceeded with the implementation of the concept into a prototype, describing the system's design, the technical and project management best practices used, as well as how playtesting was conducted. While developing our own game design process, we reference Bernard's state of the art analysis provided in *Local Multiplayer Games* (2022), who provides brief analyses of *Unrailed!* (Indoor Astronaut, 2019), *Moving Out* (DevM Games, 2020), and *It Takes Two* (Hazelight Studios, 2021). *Unrailed!* provides players with simple mechanics, they need to use an axe and a pickaxe to gather the materials needed to make train tracks and move a train, but they have only one tool of each type and limited time to complete their task (Bernard, 2022). *Moving Out* also has simple controls, as the players can jump and grab objects, but being a game based on physics the task of moving objects around together becomes a chaotic one (Bernard, 2022). Bernard (2022) also points *It Takes Two* makes use of many common and pre-existing game mechanics and gameplay elements in order to make each section of the game feel distinct from the others.

When discussing similar games together we also talked about other examples of cooperative videogames. In our first discussion to start thinking about the kind of game we wanted to make, for example, we talked about a few different games and how they worked as cooperative games. *The Legend of Spyro: Dawn of the Dragon* (Étranges Libellules, 2008), *Unravel Two* (Coldwood Interactive, 2018), *Bread & Fred* (SandCastles Studio, 2023) and *Chained Together* (Anegar Games, 2024) all use forced proximity both as a gameplay mechanic and as a way to keep the players on the same screen. In *Fireboy and Watergirl* (Oslo Albet, 2009) and *BOKURA* (tokoronyori, 2023) the player characters and the players see the world differently. In *PixelJunk Shooter* (Q-Games, 2009) and in *It Takes Two* the players interact with different things, each player has a specific mechanic that can be used differently in different contexts and have game mechanics that interact with each other. In *Magicka 2* (Pieces Interactive, 2015) the players combine elemental spells to create different effects, and they can combine each others' spells. While in *Biped* (NEXT Studios, 2020) they share control of the same player character by each controlling individual leg. At the end of that discussion we decided that we wanted to focus on making two player characters with complementary abilities.

Laura then proceeded to make a list of pairs of abilities found in *Magicka 2*, *Deep Rock Galactic* (Ghost Ship Games, 2020) and *It Takes Two*, to add them to the list of abilities that we brainstormed. In *Figure 21.* for example, are listed the various combinations of elemental magic in *Magicka 2*, in *Figure 22.* are listed the pairs of mechanics that the player characters can use in different sections of *It Takes Two*, and in *Figure 23.* are

listed all various combinations of player character abilities when playing *Deep Rock Galactic* as just two players. The objective was to create a list that could be used as a starting point to ideate on a new game based on a pair of abilities, whether it be an original idea that we brainstormed or something that had been used in order games in the past.

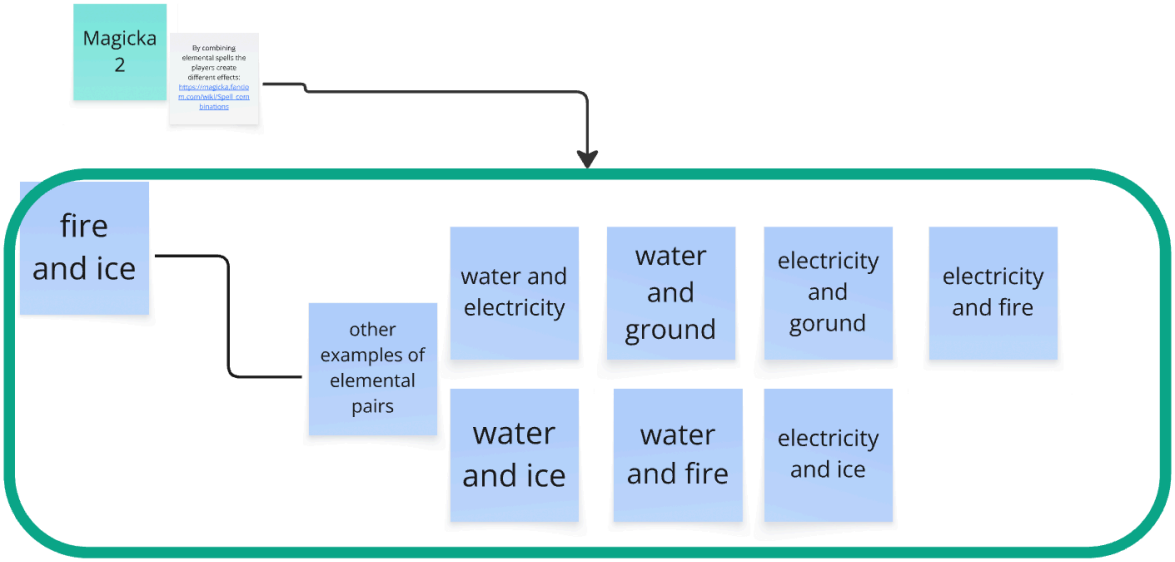


Figure 21. *Combinations of elemental magic in Magicka 2.*

Figure 22. *Pairs of player characters' abilities present in It Takes Two.*

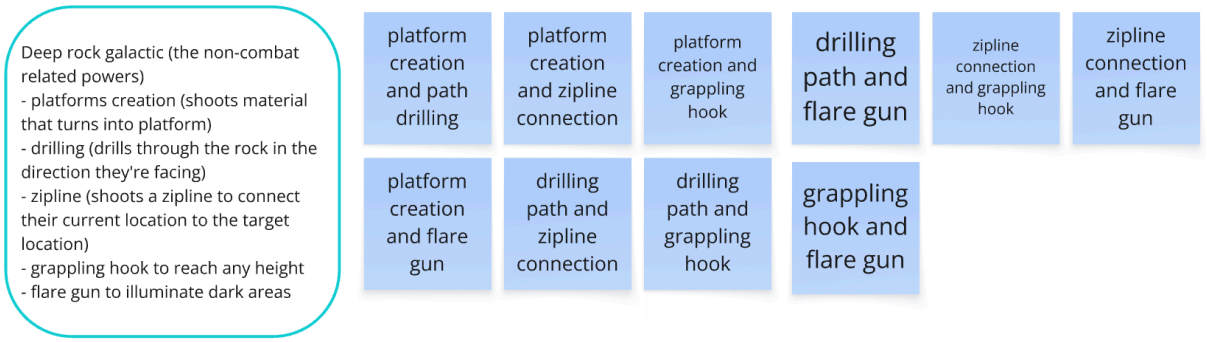


Figure 23. *Combinations of player characters' abilities that can be used in a two-player run of Deep Rock Galactic.*

The pair of game mechanics that our player characters' consist of are inspired by the attract & repel concept used in a section of *It Takes Two* in which the player characters each have one half of a magnet. Despite this being the initial inspiration, the demo plays quite differently than that section of *It Takes Two*. In *It Takes Two* the magnets are less focused on having precise control over the objects moved, and more on moving specific level design elements to open paths and as a way to enhance the players' movement during platforming sections. Our focus has instead been on using the attract/pull and repel/push abilities to move objects around in a way that is more similar to a wizard using a telekinesis spell in a fantasy world than using magnets to interact with the game world. We also put a stronger focus on the freeform nature of physics-based games, like in *Moving Out*.

3.2.1.2. Ideation of Visual Design

Game design principles centered around teamwork and enjoyment can be enforced by clear visuals, as they allow players to spend more time playing the game as opposed to figuring out their environment. Player characters give players a chance to project themselves onto the game environment, which ideally allows for deeper engagement with the gameplay experience.

In our team Hanna (Art Director) was going to be the one primarily creating and managing the visuals of the game, and therefore the final style needed to be something she would be able to accomplish within our allotted time. The goal was to be able to use premade assets for the most part, and thus the visual style of the game needed to be the kind which could be outfitted with free unity assets. We also only had one developer on the team, so this style needed to be something which would not need much additional coding to be possible.

The time frame in which the project was expected to be completed was something that needed to be scoped around, including in the design of the visuals. Because of this, the visual style needed to be something which would not take more time than allotted to achieve. The gameplay length was scoped to be less than 15 minutes of

gameplay, which meant that the style needed to be communicable within that time frame, and should be quickly understandable.

As a team we decided to create a 3D local co-op game in unity, with player characters having simple but broadly applicable abilities. The development process was expected to use cooperative game design principles. This inherently narrowed down the options for visuals, as whatever style we went with would have needed to fit the criteria of these constraints.

Our game design principles centered around designing for and supporting enjoyable cooperative play between players. While many of the principles center around gameplay design, many of them can be supported with the use of visual design. Complimentary character abilities can be portrayed with complimentary visual designs, and visual design can be used to make understanding gameplay easier for inexperienced or disabled players.

3.2.1.2.1. Preliminary Research

At the beginning of the project, Hanna (Art Director) researched various methods of creation and implementation for the art which would be present in the game. One of the methods most often used to lead the eye of a viewer is by creating focal points. Since the cooperative design goals call for accessibility, we wanted to use the visual design of the game to help players understand their objectives. This can by utilizing the elements of art to make important information stand out within the environment.

The elements of art consist of line, shape and form, space, texture, and color, the last of which encompasses hue, saturation, and value (*Elements of Art*, n.d.).

1. Line refers to recognizable paths in visuals. This can refer to straight drawn lines, or ones implied with the use of shapes and color.
2. Shape refers to two dimensional shapes, while form refers to three dimensional shapes. Both can appear in two or three dimensions.
3. Space can refer to both three dimensional space and to the feeling of space found in two dimensional imagery. It is divided into positive and negative space. Positive space refers to visual density in image, usually being the image's subject, while negative space refers to the empty space surrounding it.
4. Texture refers to both the tactile feel of art, as well as the two dimensional depiction of three dimensional texture.
5. All colors are composed of three aspects, being hue, saturation, and value. Hue refers to the place of the color on the color wheel, such as green or purple. Saturation refers to the intensity of the color, from grey to neon. Value refers to the lightness of the color, from white to black.

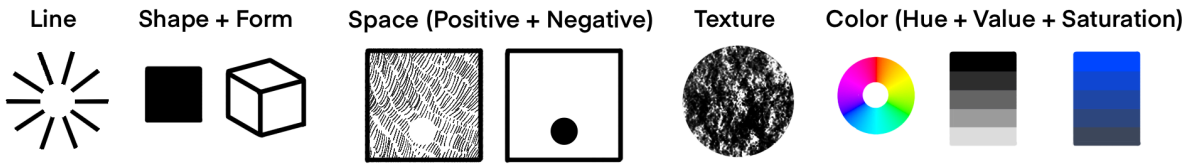


Figure 24. *Picture made by Hanna (Art Direction) to visualize the elements of art explained in this section.*

These elements can be used to create contrast, which draws the eyes of viewers to certain parts of a piece of art. For example, placing an object which has a very saturated color in front of a desaturated background will make the object stand out. This can be useful when wanting to communicate important areas of objects in an environment to players. Elements such as lines can be used to lead a viewer's eye towards areas of interest, which can be used to nudge the attention of players towards a direction.

Figure 26. *Picture made by Hanna (Art Direction) to show an example of saturation and lines.*

As for the implementation of the visual design, designing with modularity in mind became apparent as something which would allow the visual design work with the constraints of this project. Separating visuals into widely applicable parts, which in turn can be used to create unique combinations of visuals, allows for faster production of more detailed visuals.

Perry (2002) and Statham et al (2022) advise using modularity in implementation by working large details to smaller ones. Starting from greyboxing and applying large scale textures or assets, to adding finer detail afterwards allows for streamlined production while having variety in the environment. Decals, meshes overlaid on the surfaces of objects within a game, are mentioned as being used to create further depth and variety to larger assets or textures. They can be used to create the look of cracks on walls or stains on floors without needing to change the base textures or meshes.

As the team’s access to resources was limited due to the nature of this project, from team size to skill level, being able to use assets in multiple ways was important. This

allowed for the creation of contrast using the elements of art to be streamlined, which in turn aided in the application of the game design principles on a visual level.

Utilizing modularity would also allow for the use of the elements of art to be more apparent, as the various ways of drawing a viewer's eye could be added onto other pre-existing assets, without the need to modify said assets. This was important to allow for the visual design to be helpful to guiding players of varying skill levels within the environment of the game, as well as enforcing the shared goals of the players.

3.2.1.2.2. Initial Ideation

As the team brainstormed potential ideas for the core gameplay, Hanna did ability ideation in conjunction with ideation on how those abilities could be represented visually. Once the core gameplay had been established, Hanna brainstormed further ideas for the visual style and level designs for the project as shown in *Figure 27*. From these she created moodboards, and created simple conceptual sketches of how the player characters or the game environments might look. She briefly discussed these ideas with the rest of the team, and selected a medieval-revival wizard concept shown in *Figure 28*. This hit a good balance between our game design constraints and the expected player experience.

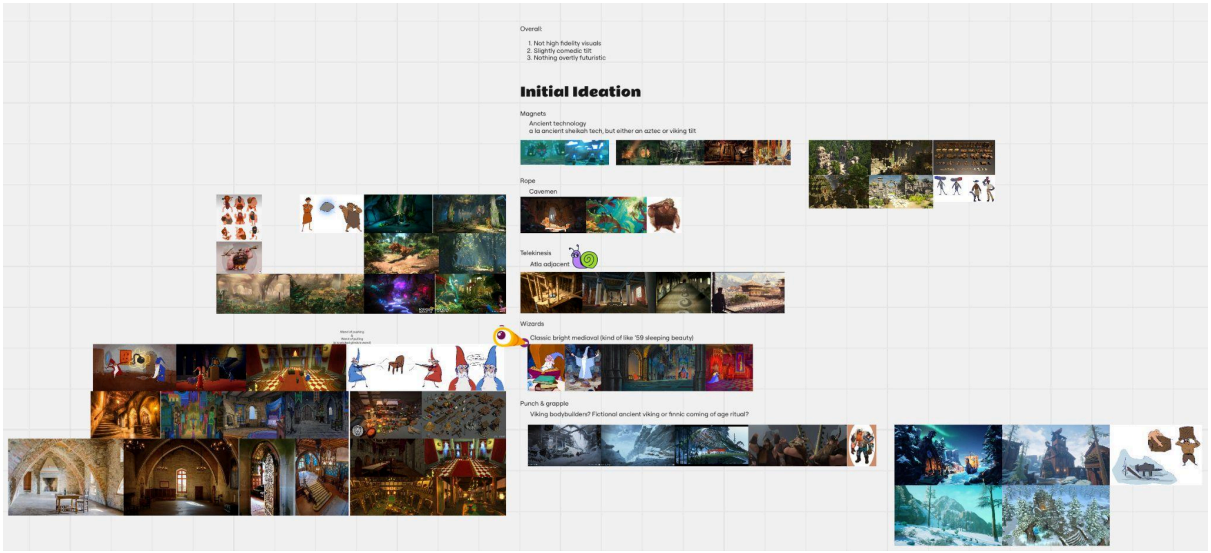


Figure 27. *Screenshot of the digital moodboards used to brainstorm ideas for the visual style of the game.*

Medieval style assets are common on the Unity Asset Store, thus allowing for a more varied selection of premade assets which the team could utilize. Bumbling wizards bickering with each other felt like a setting which would support the fun co-op experience we were going for. There were other ideas which would have fit this description and our game design principles as well, particularly one involving cavemen traveling through a cave system, however they did not fit our constraints in a sufficient manner. While cavemen would have made for interesting player characters, creating

the cave system may have required more custom built assets and textures, which did not fit our constraints. Furthermore, players will have an easier time accepting the notion of wizards being able to move objects at a distance, as opposed to cavemen having the ability to do so, allowing for less experienced players an easier time grasping the gameplay.

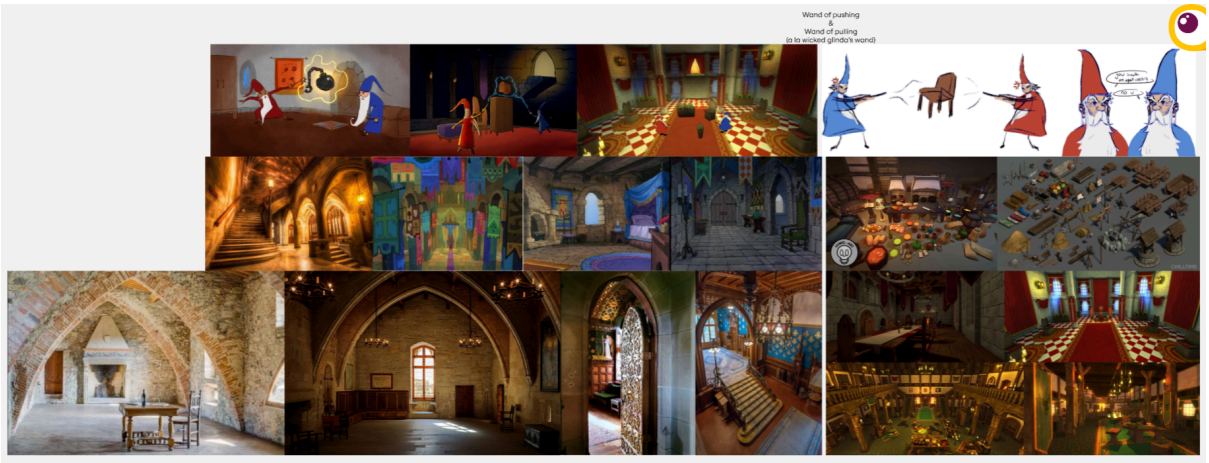


Figure 28. *Upclose screenshot of the moodboard of the chosen visual style for the game.*

After selecting a core idea for the visual design, Hanna searched for assets which would best bring the desired visuals together. She created a long list of assets which could fit the selected style, from which a smaller list of assets which would fit together and create the desired look together was created. Creating a style test, shown in *Figure 29*, with these assets in Unity led to Hanna realizing that the textures which best fit the desired style still needed to be modified in order to be as versatile as the project required.

Figure 29. *Screenshot of the style test done with the assets selected for the game's environment.*

After the core visual assets had been decided on, Hanna iterated on the concept sketches (e.g., *Figure 30*) for the characters which had been produced earlier. The

iterations were on refining the shapes of the wizards designs, as well as the colors which would be used for the two player characters to distinguish them from each other.

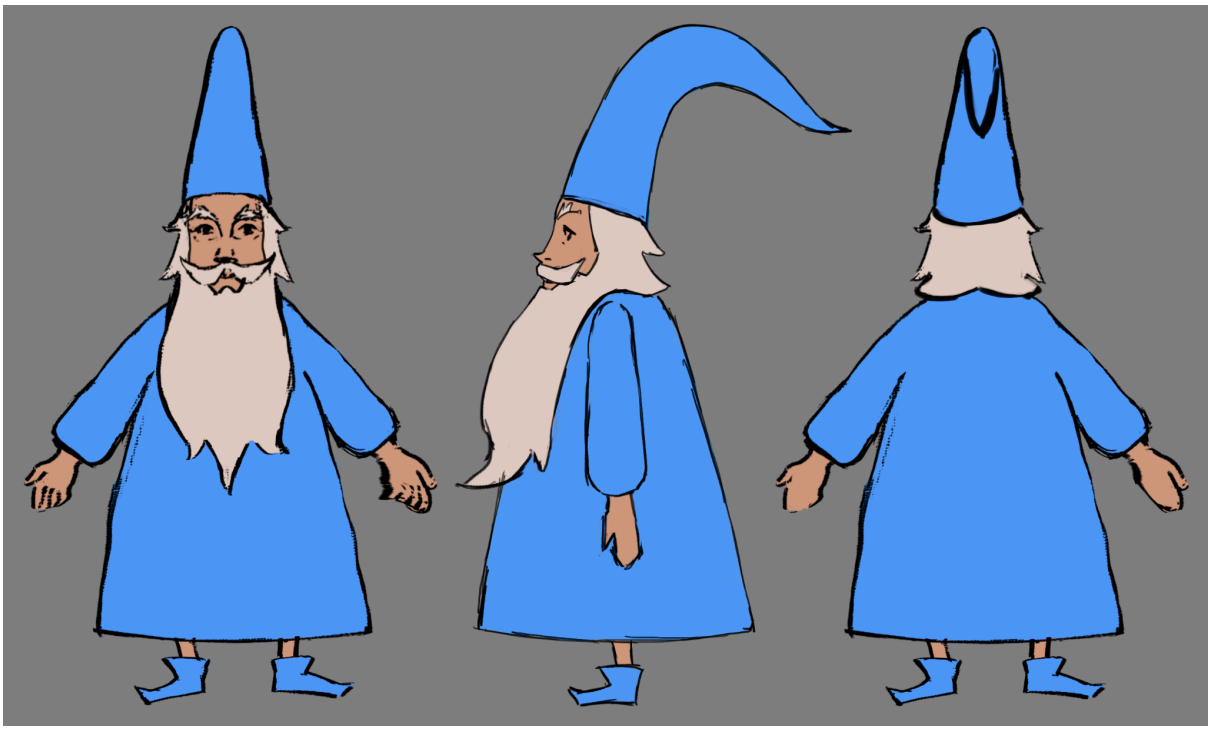


Figure 30. *Concept art of the wizard that uses the Pull ability in the game.*

3.2.2. Diagramming

As explained in the *Introduction* and in the *Design Framework* chapter, diagramming is a tool to show visually the relationship between different elements of a system. In game design it is a tool that can be used to describe user interfaces (Neil, 2012), narratives (Neil, 2012), game-flow (Dormans, 2012; Taylor et al., 2006), level design (Adams, 2009; Byrne, 2005; Dormans, 2012; Neil, 2012), gameplay (Dormans, 2012; Librande, 2010), etcetera. In this chapter we describe how we used diagramming during the design and development of our demo to visualize how the player characters and their abilities were supposed to work, the overall game loop, the smaller game loops of specific sections and challenges, and how the user interface would be navigated.

3.2.2.1. Player Character Abilities

After we came up with the initial game's idea we noted down a few questions that needed to be answered to start prototyping the player character abilities:

- How do the player characters work on a gameplay level?
- How does the camera work?

Laura (Gameplay Designer) used diagramming [*Figure 31.*] to answer these questions and to:

- Describe how the player characters' abilities would work in the simplest way possible and breaking them down into smaller concepts and components.
- Identify questions that need to be answered in order to implement the abilities and propose an answer.
- Tag elements of the players' abilities that need to be fine-tunable from the engine's editor.

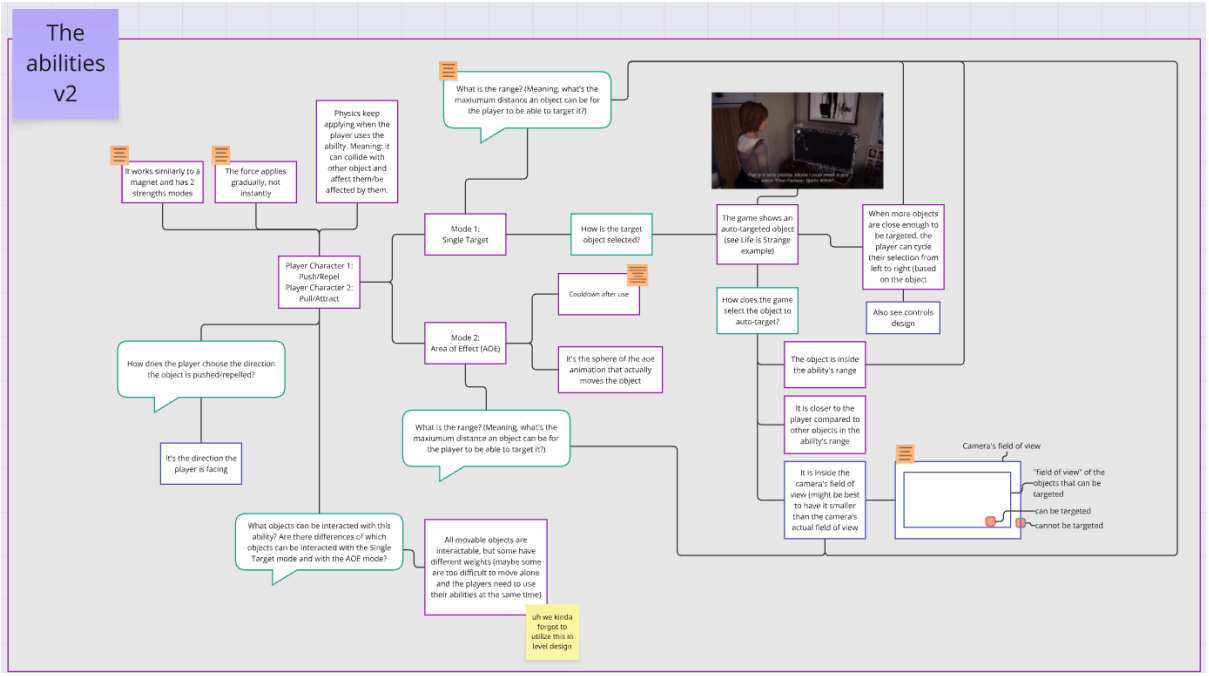


Figure 31. *Diagram of the player character abilities. The diagram is presented in the form of a flow diagram where the starting point is the player characters and their abilities, then statements or questions are brought up (green are questions, purple are statements or answers to the questions that the group had settled on previously and blue are proposed answers to the unanswered questions). And where possible examples are given to clarify, difficult to describe by words and concepts.*

Breaking down the abilities into smaller components. The diagram breaks down the Push and Pull abilities into its smaller components. It notes down that both abilities use Force, which is applied gradually to the objects affected by it, and that physics keep applying when the player uses the ability, meaning that it can collide with other objects and affect them/be affected by them. It then breaks down the abilities into their two modes, Single Target and Area of Effects, and defines better in which ways the two modes differ and where they work in the same way, as well as what needs to be done for them to be usable.

Identifying unanswered questions. They started by noting down with the purple rectangles statements about how the player character abilities work that the team had settled on. Then proceeded to connect some questions that come up when thinking of

"how would this work exactly?", coded as green speech bubbles, and added proposed answers to the questions that were still unanswered. For example, during the group ideation we had decided that one player character would Push/Repel and the other would Pull/Attract, but by making the diagram Laura noticed that we still had not answered the question "How does the player choose the direction the object is pushed/repelled?" and proposed the answer "It's the direction the player is facing". We prototyped this initial proposed answer, which is the one that is currently implemented in the demo, but after testing we noted that this does not give to the Push player as much control over their ability as the Pull has, so we might revisit this answer in the future.

Tag elements that need to be fine-tunable. When gameplay elements are visualized through diagrams like this it also simplifies noting down which elements need to be fine-tunable in-editor. Fine-tuning is usually used to adjust game feel, difficulty, camera settings and similar values. In this diagram, for example, the Force applied with different strength levels needs to be modifiable from the editor, so that the designers can figure out which values feel better to play with. Other elements that need to be fine-tuned are the range of the abilities, the cooldown of the AOE mode, the camera's position and field of view, etc.

3.2.2.2. Game Loop

Another question that we needed to answer to start prototyping was:

- What does the game loop look like?

Laura (Gameplay Designer) also used diagramming to clarify the game loop of the demo by showing the actions taken to overcome the challenges [*Figure 32.*]. There are other ways to solve the challenges, but all of them have been designed with at least one intended solution. In this case, the game loop does not have a lot of back and forth, because there aren't any real fail states. The closest thing to failing is falling to the lower floor in Challenge 2, which is why we added a ramp to walk back up. There have been talks about allowing players to reset some puzzles, like Challenge 3 which has many steps and having to re-do things can become tedious if the players fail multiple times, or adding alternative paths that are more difficult.

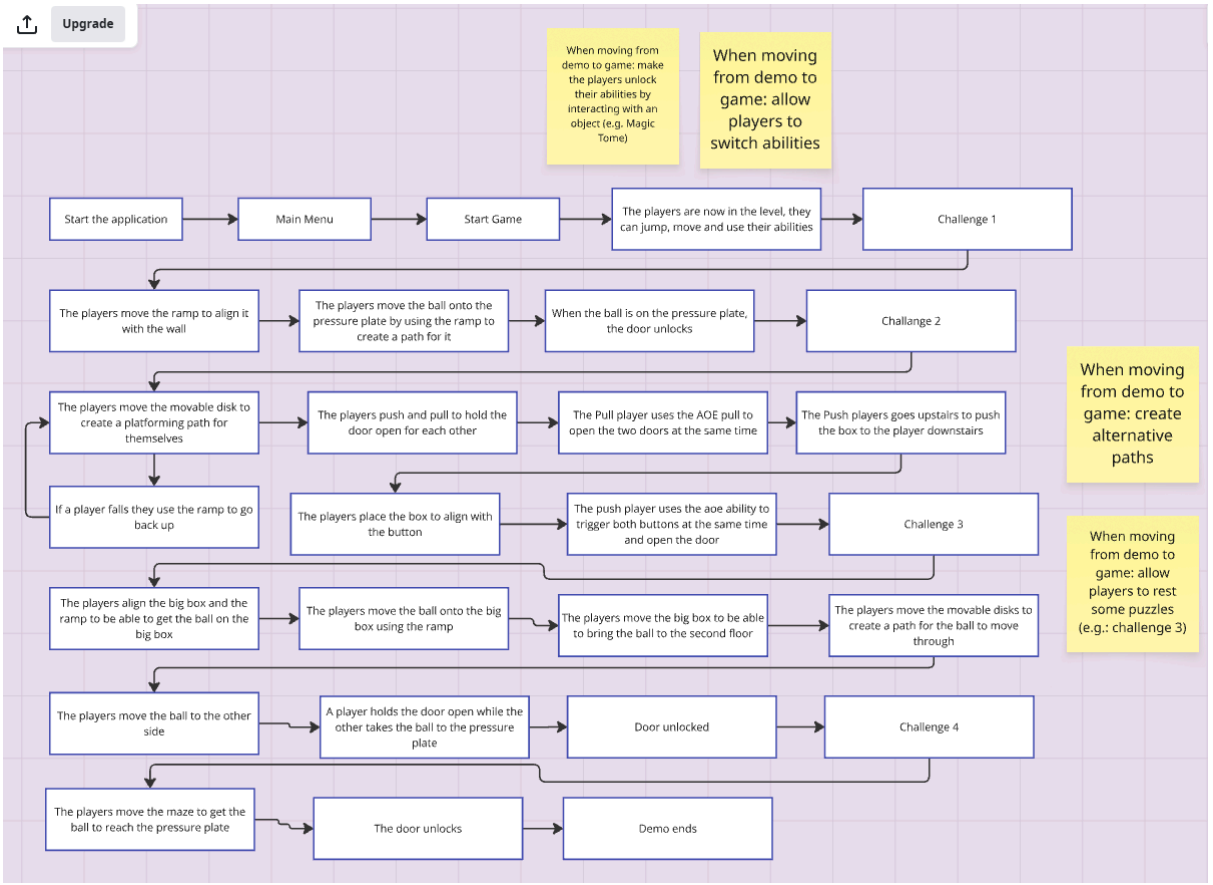


Figure 32. *Diagram of the demo's entire gameloop. More explanations in Figures 29-32.*

3.2.2.3.1. Challenges' Game Loops

Diagramming was also included in the design templates that Laura and Mikkel (Level Designers) used to ideate and design the challenges for the demo. Some early examples of these diagrams are shown in *Figure 33.*, *Figure 34.*, and *Figure 35.*, which we used to create the prototype. These loops are used to illustrate how the players would navigate through the prototype, and have been iterated on and revised with the insight gathered from the playtests, as explained in the *Iterative Design* section of this chapter. Overall the game challenges loops of the prototype are simpler [*Figure 36.*, *Figure 37.*, *Figure 38.*, and *Figure 39.*] than the prototype's and present one possible solution to the challenges while still leaving room for player creativity.

Diagrams are very informative from a programmer's perspective as it is much easier to grasp a concept when they are given a diagram that resembles things that are taught to programmers and computer science majors, in this case it's mainly 'UML diagrams' (Tavares et al., 2021). *"Unified Modelling Language (UML) diagrams, which are accepted as a standard to depict object-oriented design models. UML diagrams make it easier to identify the requirements and scopes of systems and applications by providing visual models."* (Koç et al., 2021).

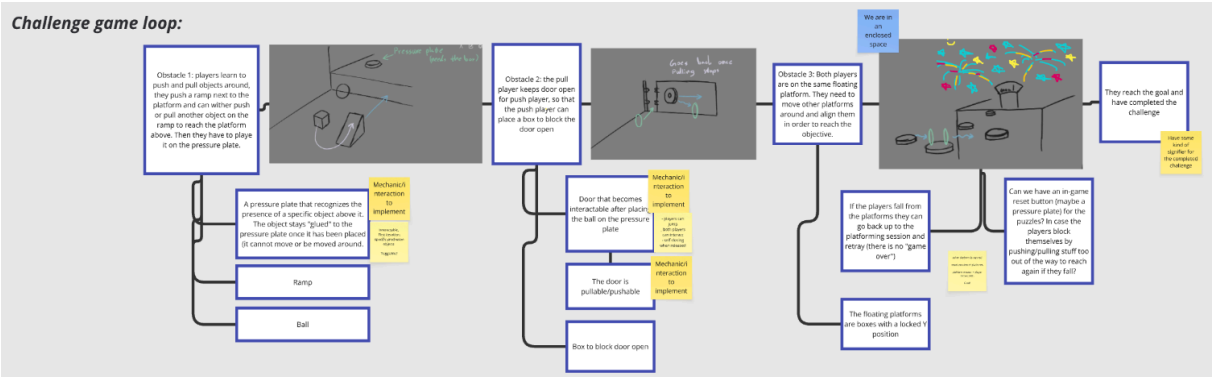


Figure 33. *Early game loop of the first section of the prototype. In this early prototype game loop we have three parts, the first one being to move a ramp to a ledge and taking a box up onto a pressure plate. The second is for one player to open a sliding door and the other player puts a box in the way so it stays open. And the third where the players have to work together to manipulate many floating platforms to cross a ravine.*

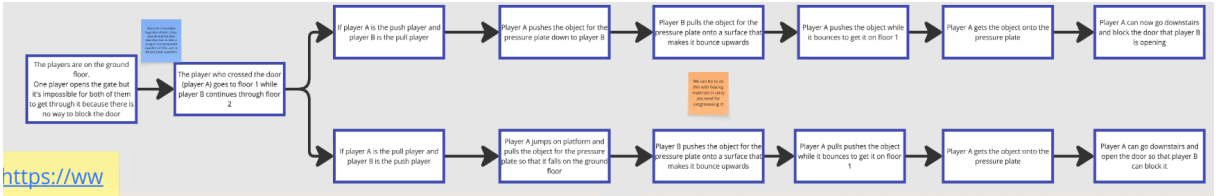


Figure 34. *Early game loop of the second section of the prototype. In this section we explain a puzzle containing multiple verticalities as well as a feature where we split the players up into different parts of the level.*

This was seen in practice when Hallur (Programmer) was working on the game mechanics: there was always a core diagram to look at to see in what context a mechanic would be used and therefore how its system architecture and backend programming slotted in with other mechanics. This can be most easily seen by comparing *Figure 36.* and *Figure 38.* where both Challenge 1 and Challenge 3 start by having the players move a ramp up against another object, this can be read as being the same basic mechanic, but in reality by reading the diagrams the reader can conclude that one of the ramps collides with a static object while the other collides with a non-static movable object. This might seem arbitrary but can save a developer valuable time, especially in our scenario where in Challenge 1 the ramp is thrust against the ledge with no thought, while in Challenge 3 precautions were taken into making sure that when the two movable objects would collide (ramp and big box) that they wouldn't move each other excessively as object physics are a big part of our demo.

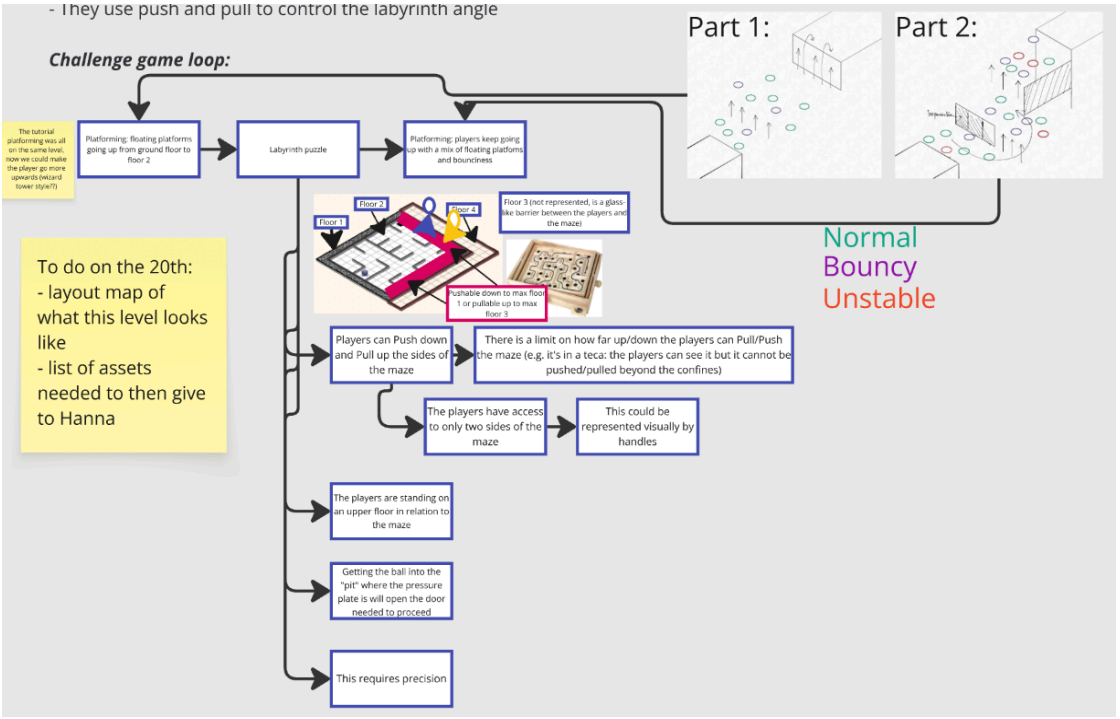


Figure 35. *Early game loop of the third section of the prototype. This section describes a three part puzzle involving two floating platform puzzles and a tilting maze puzzle. The floating platform puzzles are vertical puzzles where the platforms are 'bouncy' and therefore would propel teh players across the rift. While the tilting maze puzzle is a maze that contains a rolling sphere, the players can tilt the maze on two axes and by tilting it correctly get the sphere on a pressure plate.*

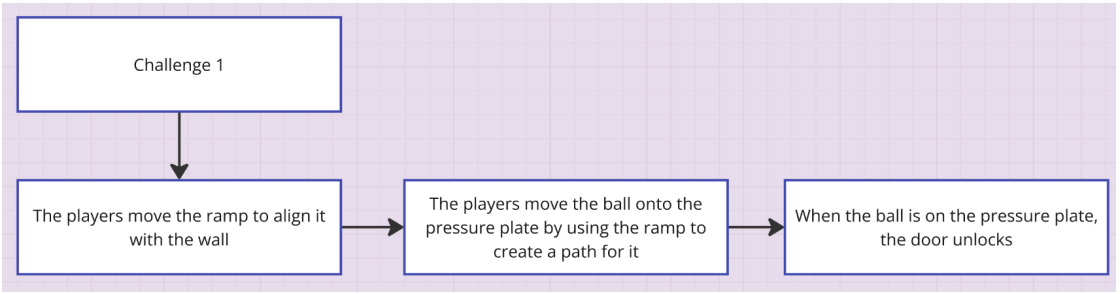


Figure 36. *Game loop of challenge 1 in the demo. The game loop is comprised of three steps: moving the ramp to the wall, moving the ball to the pressure plate, and triggering the opening of the door when the ball is on the pressure plate.*

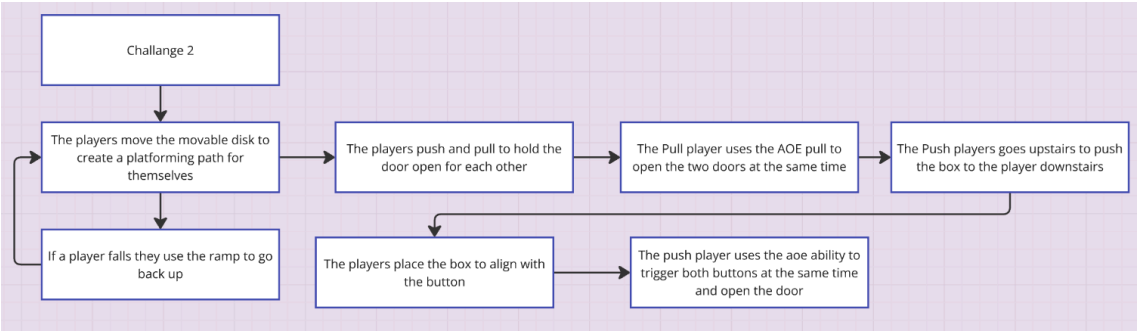


Figure 37. *Game loop of challenge 2 in the demo. The game loop is sectioned into two puzzles, the first where the players move a floating platform to get over a ravine (if they fall in the ravine they get back to the starting position via a ramp), the second where they go through a pull/push sliding door, use the AOE abilities to effect multiple objects at once to get to a box they push down to a lower level, then they use that box to press multiple pressure plates at once.*

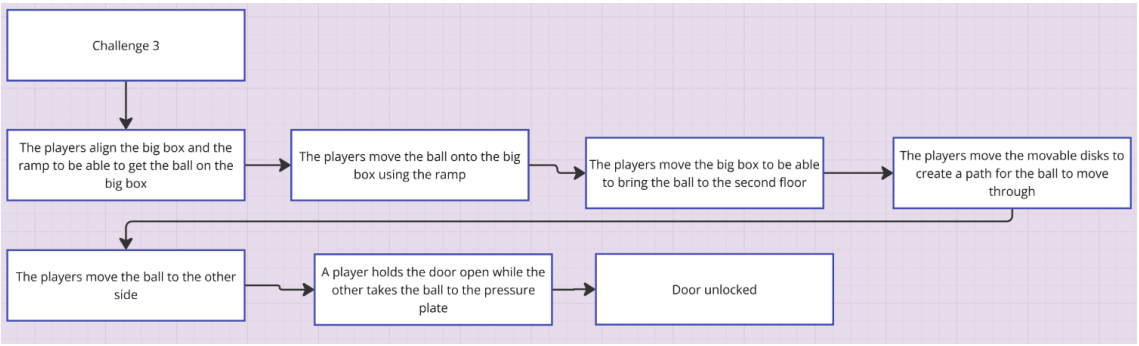


Figure 38. *Game loop of challenge 3 in the demo. The game loop is a linear progression through a A to B puzzle. where the players have to move a ramp and platform together, push a ball onto the platform. Then move the platform with the ball on it to another section where they manipulate floating platforms to make a bridge they then move the ball across. At this point they open a sliding door and on the other side of that door they need to put the ball on a pressure plate that opens the door to the next section.*

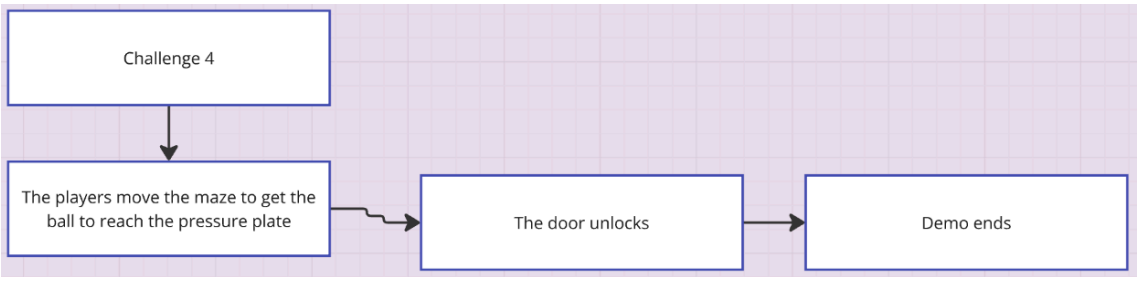


Figure 39. *Game loop of challenge 4 in the demo. The game loop is comprised of three steps: The players moving the maze do that the ball in the maze reaches the pressure plate, the door unlocking and then ending the game.*

3.2.2.3. User Interface: Menus

We also used diagramming to show how the player would navigate the menus as shown in *Figure 40* and *Figure 41*. *Figure 40* shows that when the players start the application they should be met by the main menu, which can be navigated to either start the game, open the settings, see the controls schemes, view the credits or exit the game. From the settings the player would need to be able to access settings to adjust the game to the screen size and have control over the master volume, the music volume and the sound effects volume. The diagram of the in-game menu in *Figure 41* presents itself with a similar structure to the main menu, but it is noted that the game is paused while the menu is open and there is a Resume button instead of start game to close the menu and unpause the game, as well as a Return to Main Menu button instead of the Credits.

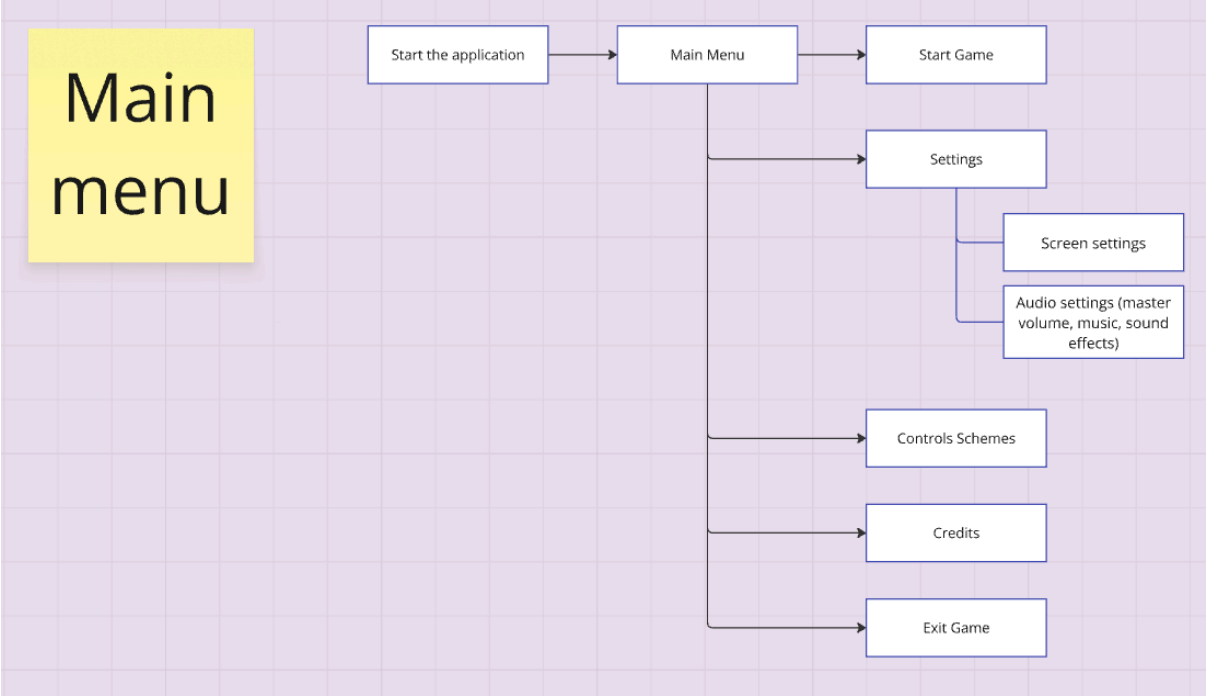


Figure 40. *Basic diagram of the main menu. There are 4 states for the main menu and 2 actions. The states are the main menu screen, the settings screen, the control scheme screen, and the credits screen. The actions are pressing either the "Start" or "Exit" button.*

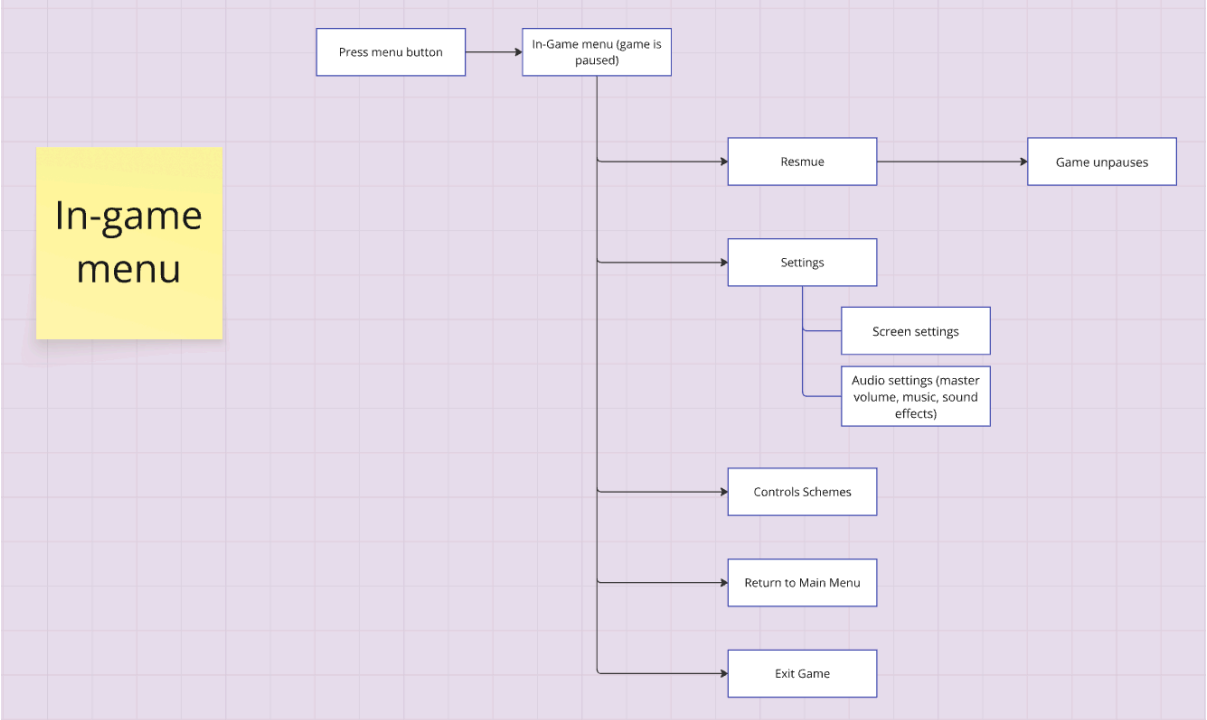


Figure 41. *Basic diagram of the in-game pause menu. The in-game pause menu has the same states as the Main menu [Figure 40.] and two actions, the "Resume" (Instead of the Main menus "start" button) and "Exit" buttons.*

3.2.3. Sketching

We mainly used sketching as part of the design process of the level design, and of the game's visual representation of the environment and player characters. These sketches were instrumental for Hallur (Programmer) to understand what was expected for the challenges. As when communicating an idea from word of mouth is the fastest and most straightforward way of communicating an idea. Having a sketch that shows what a designer expects is solid evidence of what they want, even if they have a hard time conveying the exact details. When a developer has a sketch to show what a designer wants, the developer has an easier time with filling in the blanks that might have been left behind by less technically aligned members of the team, or things that don't seem to be as important to the designer. This is mainly in relation to the figures where objects are drawn and interactions are written out in plain text.

3.2.3.1. Level Design

Sketching has been part of the challenges' level design process both to ideate on the level design and to illustrate the design and communicate it to the rest of the team. Mikkel (Level Designer) mainly used hand-drawn sketches to illustrate specific interactions between the players and the environment [*Figures 42.-47.*], while Laura (Level Designer) used the online tool DungeonScrawl[16] to sketch a map of the environment [*Figures 48.-52.*].

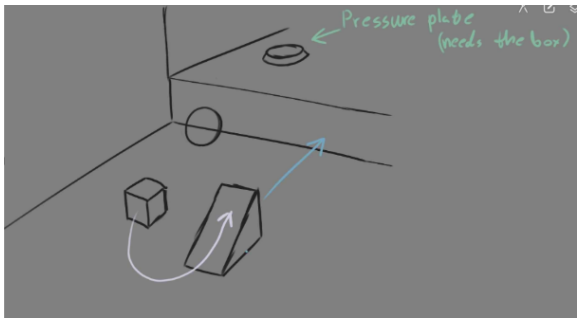


Figure 42. *Mikkel's sketch illustrating the concept of having the players use a ramp to bring an object from one floor to the other.*

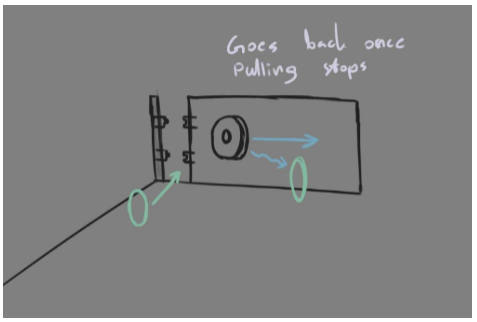


Figure 43. *Mikkel's sketch illustrating how a sliding door would work.*

Figure 44. *Mikkel's sketch the players creating a platforming path by moving floating platforms around.*

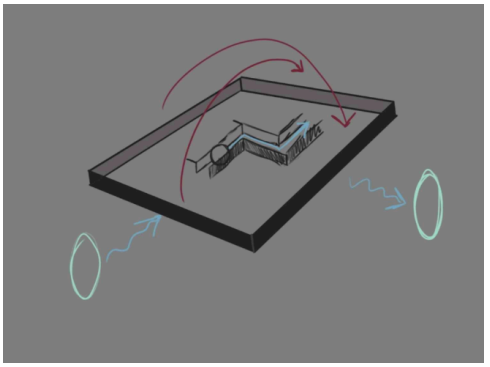


Figure 45. *Mikkel's sketch illustrating the concept of the players manipulating a maze.*

[16] Dungeon Scrawl is a free tool usually used to create maps for TTRPGs: https://www.dungeonscrawl.com/

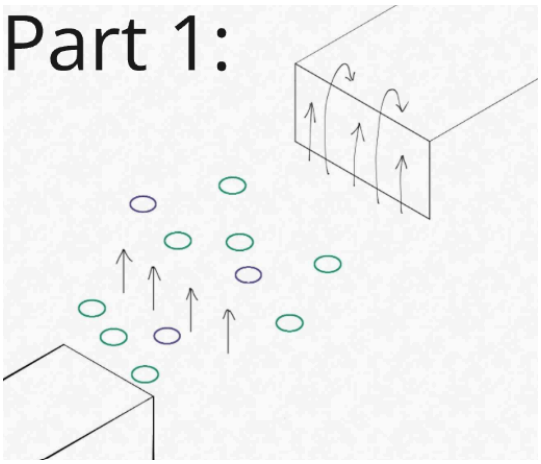


Figure 46. *Mikkel's sketch illustrating a platforming section with bouncy floating platforms (purple) and regular floating platforms (blue).*

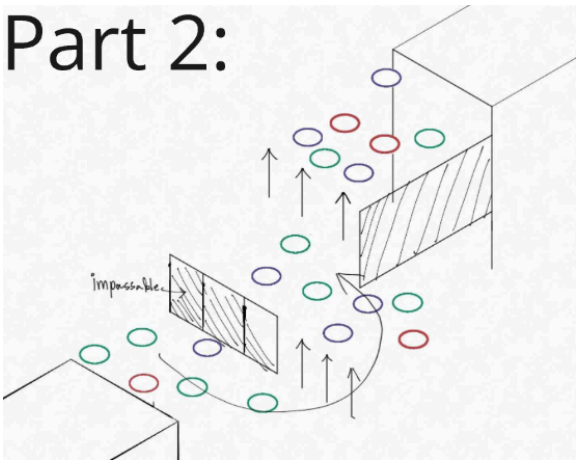


Figure 47. *Mikkel's sketch illustrating a platforming section with bouncy floating platforms (purple), disappearing floating platforms (red) and regular floating platforms (blue).*

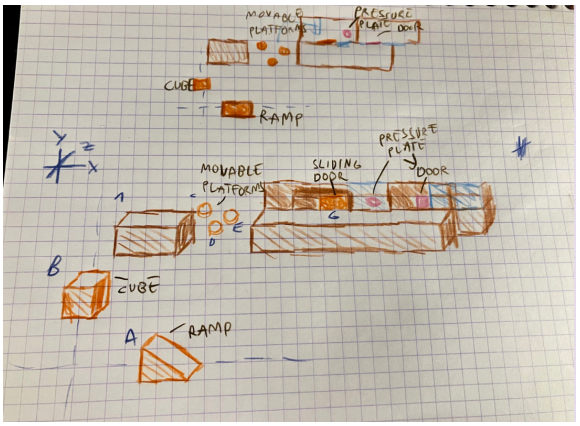


Figure 48. *Laura's sketch a section where the players need to create a path for a ball to reach a higher floor.*

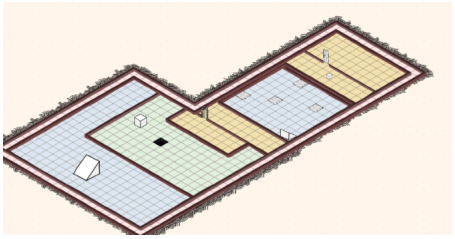


Figure 49. *Laura's sketch on dungeon scrawl with the prototyped version of the first section of the game.*

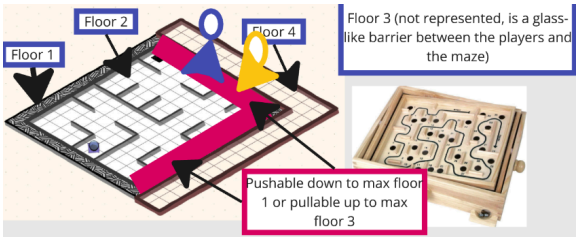
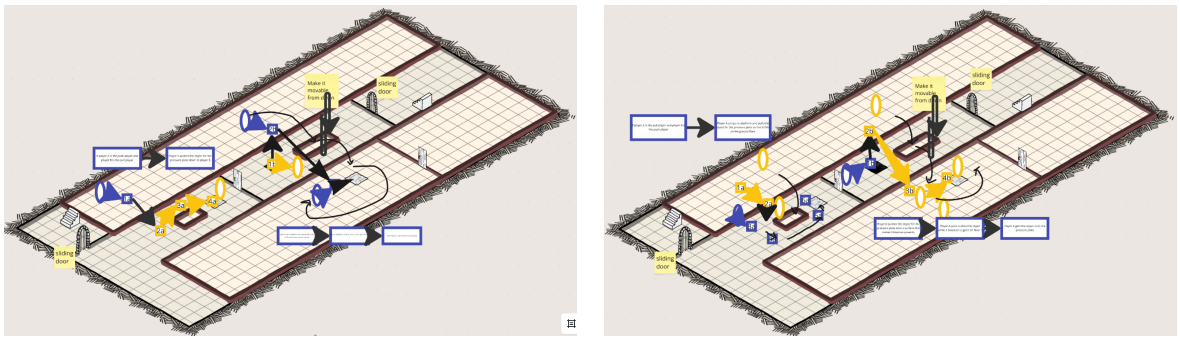


Figure 50. *Laura's sketch on dungeon scrawl with the prototyped version of the last puzzle of the game.*



Figures 51 and 52. *Laura's sketch on dungeon scrawl with the prototyped version of a now discarded section of the demo where it was intended for the player to be split and send objects to each other.*

Laura (Level Designer) used these sketches as a reference when first implementing early challenges' design and later on in the development process as a tool to analyse the design and identify issues or areas of improvement [*Figure 53.*]. The final result of this process is illustrated in *Figure 54.* Mikkel (Level Designer) also used early sketches as a reference, particularly when experimenting with early iterations of levels and mechanics such as the floating platforms [*Figures 44, 46, 47*], as well later on when analysing and re-iterating after in-development playtests. Hanna (Art Director) used these sketches in conjunction with lists of the types of assets which would appear in the levels to find and create the appropriate assets.

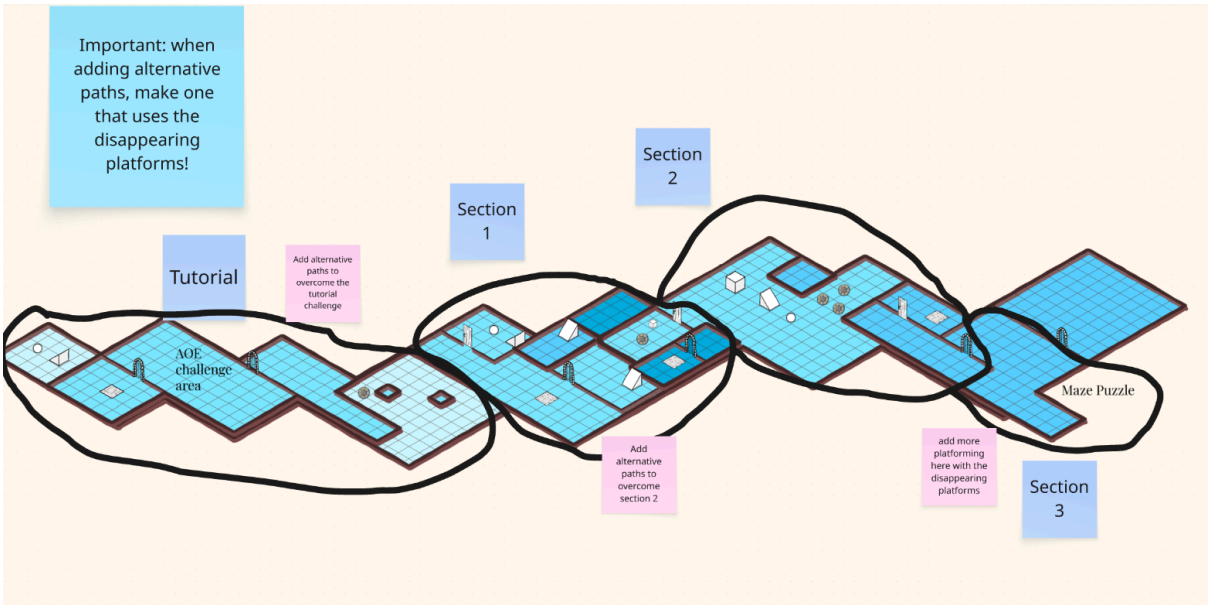


Figure 53. *Laura's sketch on dungeon scrawl showing the level design of the prototype, which will then be simplified more for the demo.*

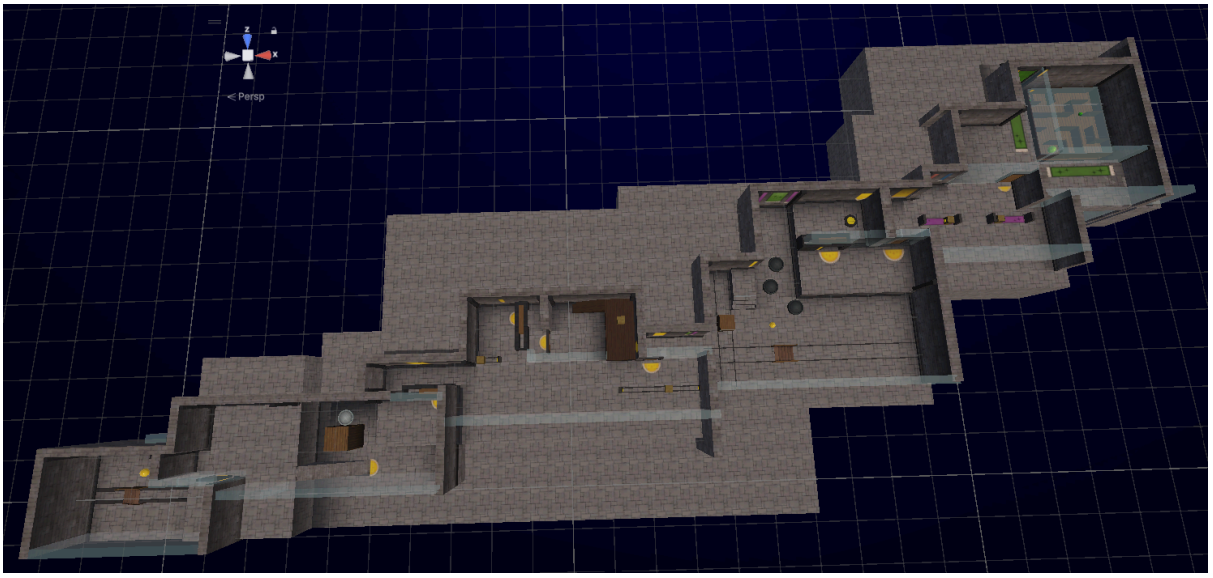


Figure 54. *Screenshot of the demo's level design made by Laura (Level Designer), Mikkel (Level Designer) and Hanna (Level Artist) inside Unity's scene editor.*

Hallur (Programmer) used sketches as a reference tool when implementing features. Sketches were instrumental to know what proportions to keep in mind, realising why a feature is important in the grand scheme of things, and to stay focused on the main impact points of a given feature. For example, *Figure 55.* shows clear proportions in relation to the player characters, emphasises importance as obstacle to be overcome by the players cooperating, and highlights key attributes using text and differing arrows to signify that the movement goes along the straight arrow and the players ability is signified by the wavy arrow, while the text explains that the door needs to automatically close after the players ability stops affecting it.

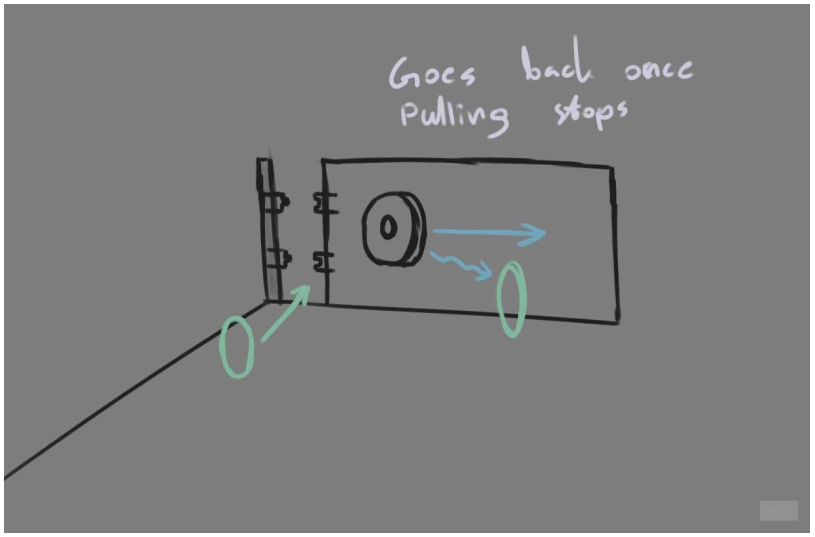


Figure 55. *Sketch of the sliding door with clear goals and key points. One player would pull the door open while the other passes through.*

3.2.3.2. Visual Representation of the environment

As mentioned earlier, sketching was used to visualize how the environment may appear during the initial phases of ideation for the visual style of the project (e.g. *Figures 56 & 57*). These sketches were informed by the core gameplay, and how the player character's abilities may be used during gameplay. These sketches served to communicate the overarching aesthetics, rather than specific design details. Because the visuals of the environment were to be composed of externally sourced assets, there was no need to design specific objects found within the environment.

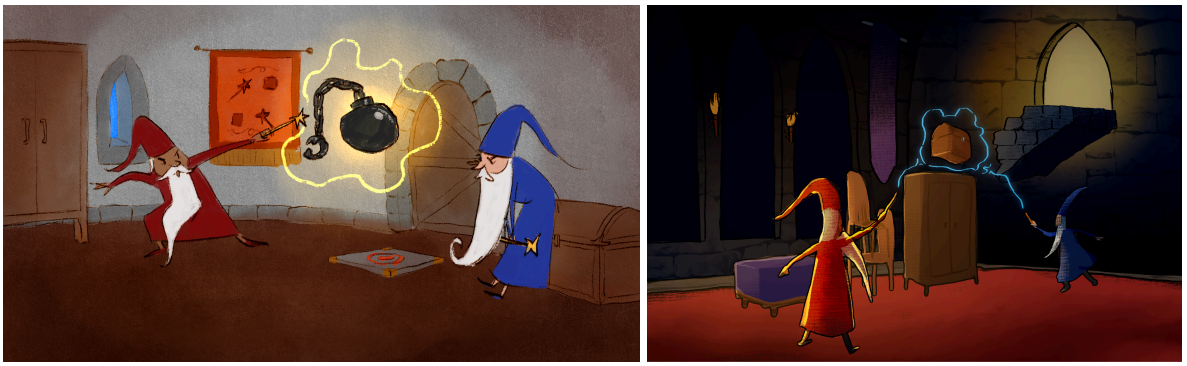


Figure 56. & 57. *Sketches of the two player characters using spells to move objects around.*

The only assets within the environment which were fully original were digitally painted tapestry and rug assets. Hanna created sketches of various shapes of tapestries and rugs, which she turned into finalized assets afterwards, shown in *Figure 59*.

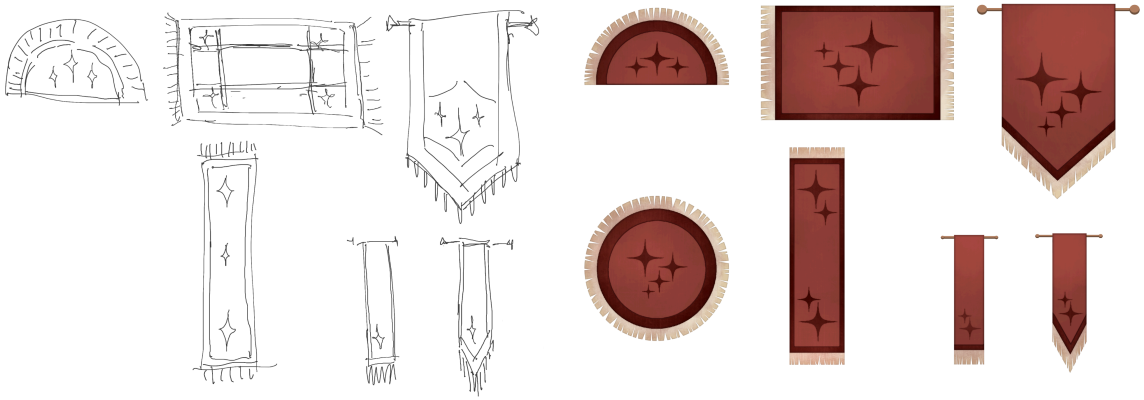


Figure 59. *Sketch of the painted tapestry and screenshots of the painted assets.*

3.2.3.3. Visual Representation of the Player Characters

Figure 60. *Initial sketches of the player characters as wizards.*

While sketching for the player characters began in a similar manner to the environments, with a focus on conveying the aesthetics and mood of the visuals (e.g. *Figure 60.*). However, since the team wanted to create original assets for these characters, their designs needed to go through multiple rounds of iterative sketching before being finalized. This sketching mainly focused on the sizes and shapes of their bodies, as well as their color palettes, as seen in *Figures 61-62*.

Figures 61 and 62. *Iterative sketches of the player characters' visual design.*

After the design of the player characters had been finalized, the 2D designs were brought into a 3D modeling software, Blender. There, the designs were used as guidelines for the modeling process, with the planes of the meshes being brought in line to where they appear in the 2D designs. The color from these designs and other additional elements, such as their eyes and eyebrows, were applied onto the models during texture painting.

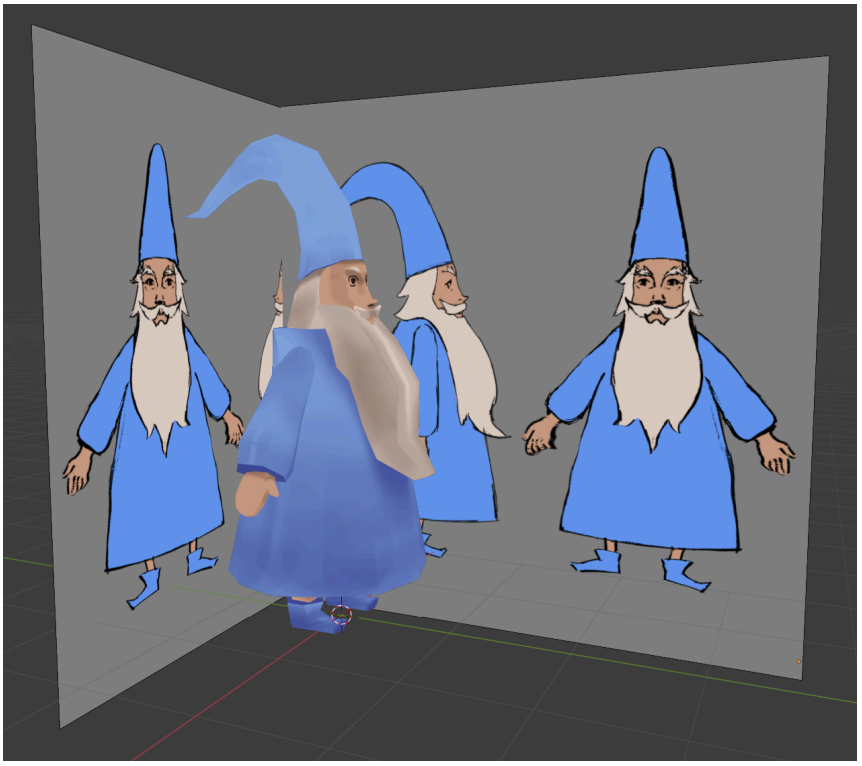


Figure 63. *Screenshot of the model of one of the player characters.*

3.2.4. Creating templates for collaborative game design

One design method that was not included in our original *Design Framework*, but that came up during the initial design phase has been the creation of templates for collaborative design. Laura (Level Designer) and Mikkel (Level Designer) both ideated on different challenges designs while working individually. So, to maintain our design directed towards our goals and be cohesive, Laura (Game Design Lead) created a template of how to communicate a challenge's concept as shown in *Figure 64.* The template asks the designer to explicitly state "What's the players' goal?", "How is the Push/repel ability being used to overcome this challenge?", "How is the Pull/attract ability being used to overcome this challenge?" and "How do the players collaborate? Do they combine their abilities? Do they take turns? Etc.". The template also suggests using references, images, sketches and diagrams to explain the design. This allowed them to start drafting some initial designs shown in *Figure 65.*, which then Laura and Mikkel discussed together with the objective of creating more concrete level designs to graybox into the prototype. In this case, they included a diagram showing the game loop for each challenge and sketches to use as reference when greyboxing, shown in *Figure 66.* While doing so, they also tagged elements of the level design that would require the creation of new features to implement, which is how they ideated some types of interactions that gave us more level design options.

Example of [Challenge Type: e.g.: unlocking door] Challenge Version [A, B, C, D, etc.]

What is the players' goal?
[type here, add reference images if relevant, make diagrams if needed, etc.]

How is the push/repel ability being used to overcome this challenge?
[type here, add reference images if relevant, make diagrams if needed, etc.]

How is the pull/attract ability being used to overcome this challenge?
[type here, add reference images if relevant, make diagrams if needed, etc.]

How do the players collaborate? Do they combine their abilities? Do they take turns? Etc.
[type here, add reference images if relevant, make diagrams if needed, etc.]

Figure 64. *Template for the challenges' concept design.*

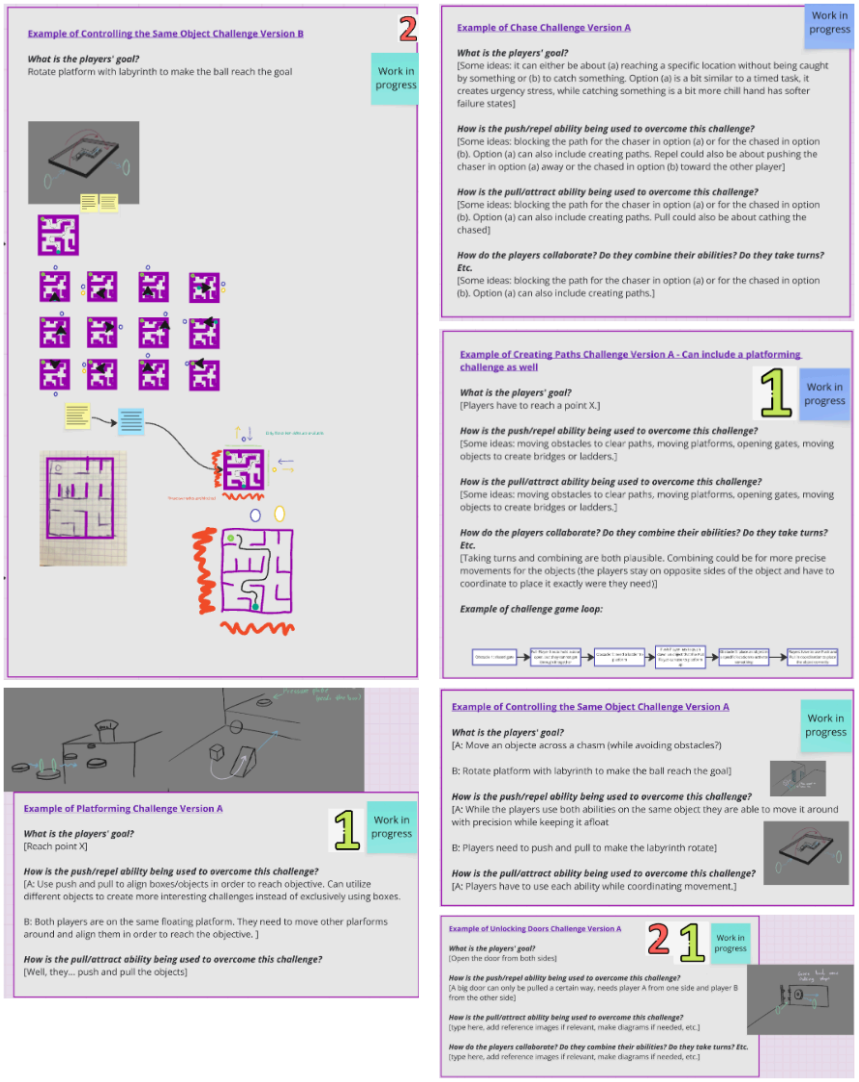


Figure 65. *Drafts of the challenges concepts.*

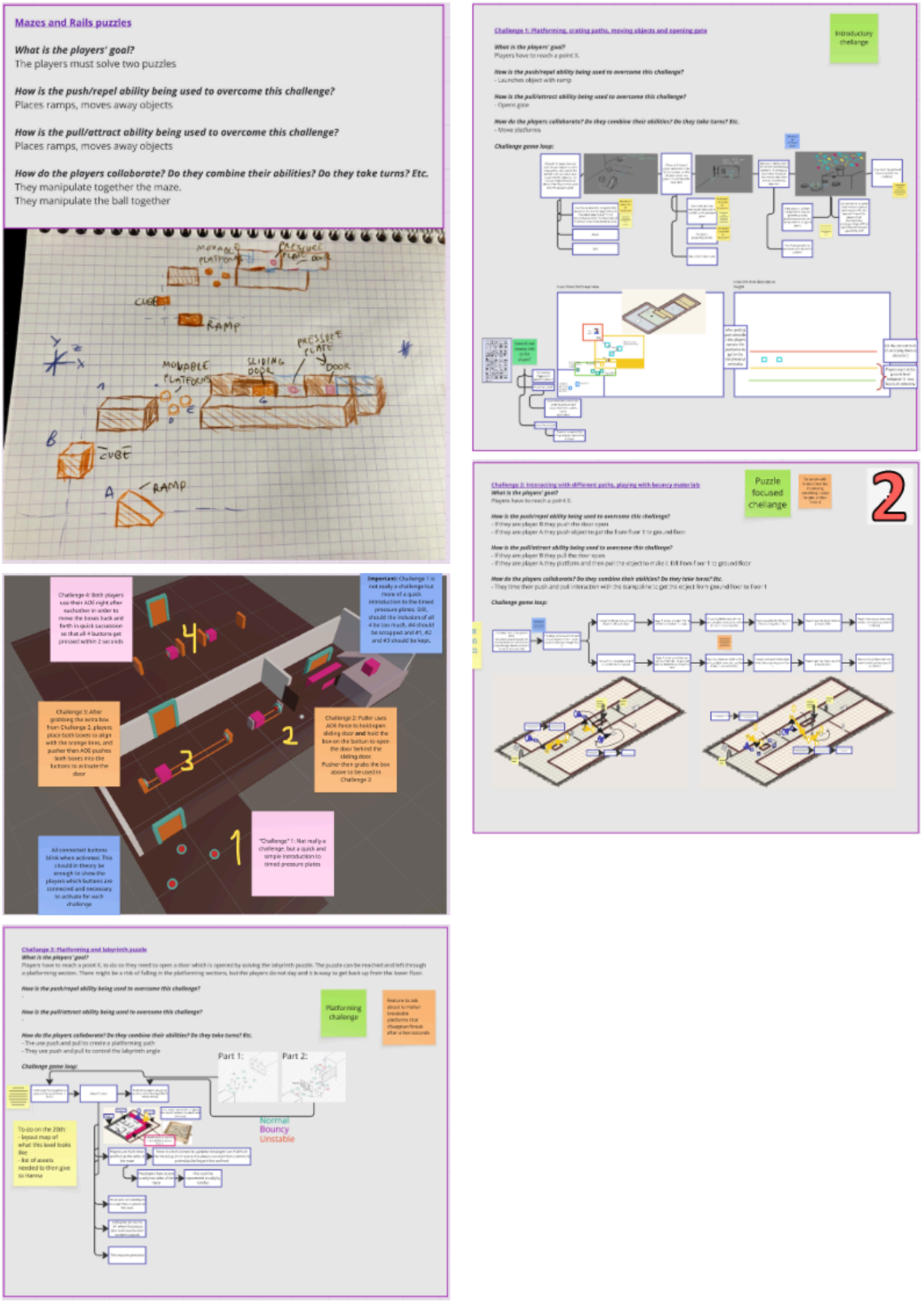


Figure 66. *Concepts of the challenges that we prototyped.*

3.2.5. Iterative design and external playtesting for iteration

Prototyping is another method that we mentioned already in the *Introduction*. In the development of our prototyping we applied iteration as elaboration and refinement for our player characters.

Although we were strict about keeping them simple and not adding more abilities other than push/pull, we needed to flesh out how they would actually be implemented, which meant using iteration as elaboration to some extent. We know that we wanted to have "One player can Push and the other player can Pull". From that starting point we worked on the following complementary ideas: "Both of them have two modes: "AOE Push/Pull and Single Target Push/Pull" and "Both of these modes have three different levels of force used to push/pull". We elaborated on these ideas to understand what they would mean in terms of implementation. "Both of them have two modes: "AOE Push/Pull and Single Target Push/Pull" meant that for the AOE mode we needed to determine the max radius of the area of effect, and for the Single Target it meant that the player characters also needed a targeting system that can show which object is being targeted by which player. "Both of these modes have three different levels of force used to push/pull" meant that the players need a visual indicator of what the current strength[17] level is. Initially we used a Heads-Up Display (HUD) to be able to see which force level is being applied to each mode. While testing, however, we noticed that players were not looking at the HUD, as they were focused only on the player character and thus did not register the information on the corners of the screen. So we decided to add visual effects on the player characters and the targeted objects to show both the force strength level and the current target. Similarly, we noticed confusion among some players when using the AOE, as it had no visual feedback when activated. So, we added a visual indicator for its activation.

For the level design we initially went in the direction of simplification. We had gathered many ideas of challenges that could be used with the Push and Pull abilities and we drafted concepts for each of them. This process allowed us to whittle away the ideas that either did not allow both players to be active participants in the collaboration or to remove those that were too complex for our resources constraints. Like with the player's abilities, the elaboration came in afterwards to refine the selected idea. During this process we grayboxed a test scene where the designers could test out different design concepts and ideate more through grayboxing and combining the implemented features in different ways. Grayboxing consists in creating a level with all the intended functionality but with an environment made only of basic geometrical shapes, instead of using finalized assets. This allows us to focus on the gameplay aspect of the level design and to iterate on it without having to re-make the environmental art of it with every iteration. It also allows us to test the gameplay and identify issues early on. This allowed us to have a better idea not just of the game feel, but also of what's possible and what is not possible with how the game mechanics and features have been

[17] ***Ability Strength.*** How much Force is applied with the player characters' abilities.

implemented so far, as well as to ideate on new design concepts based on that. This would fall more into the opportunistic iteration described by (Kultima, 2015). In doing this, we are also continuously analyzing the designs (Adams, 2009), in order to evaluate if it is contributing to achieve the design principles.

So one frame of iteration does not exclude the other, and it is likely that more than one of them will be used to pursue specific goals. In our case the sequence has usually been:

1. Iteration by simplification: narrow down to the core ideas first, define their boundaries in order to avoid making the prototype more complex than what we can implement. For example, we wanted the players to be able to move objects around with their abilities, so we implemented Movable Objects with the simple shapes of cubes, spheres, etc., which are the elements of the game that the players can use their abilities on.

2. Opportunistic iteration: explore the core concept by playing around with a proof of concept as soon as it's available, it will make the next iterations by elaboration more concrete. For example, the designers played around with the Movable Objects, exploring what it felt like to move them in-game and how it felt natural to use them, like creating paths to move objects from one floor to the other.

3. Iteration by elaboration: elaborate on paper on the core concept with the most complementary ideas. For example, we designed two challenges that elaborate on the idea of creating paths to move an object from a point A to a point B, introducing pressure plates to place the object onto in order to open doors etc.

4. Opportunistic iteration: take the core concept and the complementary ideas into a playground area to try out different interactions and scenarios. For example, we tried out different level layouts for the challenges ideas mentioned above, modified them while playing around with them and experimenting.

5. Iteration by elaboration: elaborate on the core concept and complementary ideas and draft the level design. For example, from what was learned by experimenting with the basic layout in the playground area, we designed an actual level to graybox and prototype.

6. Opportunistic iteration & elaboration: graybox the level design, try it out and continue changing it and elaborating on it. For example, after grayboxing the level mentioned previously we tested it out, both between us and with external playtesters, and from those tests we found ways to improve or change the layout.

3.2.5.1. In-development playtesting for iteration

Once we had the grayboxed levels ready and the player characters abilities[18] prototype we were able to bring the prototype to external playtesters. Both during the prototyping phase and while developing the demo we have used testing with external playtesters with the objective of using the data gathered to improve the gameplay design. We conducted two types of playtests:

- Usability and Accessibility: with the objective of checking if the prototype is working as intended and if it is understandable and accessible.
- In-Development Cooperative Gameplay Evaluation: with the objective of evaluating if the prototype succeeds in enabling cooperative play and to identify areas of improvement to iterate on our prototype's design.

Both types of playtests informed the changes that we made throughout the different iterations of our prototype, as well as the design that we settled on for the demo. Most of the changes that we made based on the data gathered during these playtests would fall under iteration by simplification, iteration as elaboration, and opportunistic iteration.

The playtests conducted during the development of the demo differ from the playtests that we discuss in the *Players' Experience* chapter both in goals and playtesters demographic.

Goals. Both the Usability and Accessibility playtests and the In-Development Cooperative Gameplay Evaluation that we developed during the development of our demo had the objective of gathering qualitative data to improve our demo's game design, while the Post-Development Cooperative Gameplay Evaluation had the objective of gathering data about the players' experience with the finished demo to answer our research question.

Playtesters demographic. While for all our playtests we have been looking mainly for playtesters who were interested in playing cooperative games with someone they know (friends, partners, family, etc.), for our in-development playtests we sought the people most available to us, which consisted of MSc Games students from the IT University of Copenhagen, while for the post-development playtests we accepted data only from people who did not study games, or make or write about games for a living. This means that the feedback we got from the two groups was different: other MSc Games students gave us feedback not just from a player's point of view but also from a peer's point of view, while the second group of playtesters was representative of a more general audience.

[18] ***Player Characters Abilities.*** The ability that is unique to each player character, one player character can Push Movable Objects away from themselves while the other can Pull Movable Objects towards themselves.

In the *Appendix* we have included the playtesting protocols and reports of the In-Development Cooperative Gameplay Evaluation playtests.

3.2.5.2. Iteration by simplification

During the development of our demo we used iteration by simplification to make various elements that create the demo's gameplay simpler, more concise and easier to use and understand.

Simplification for ease of use. We initially had the Single Target Mode[19] and the AOE Mode[20] function differently and separately: the first one used Force[21] and the second one Impulse[22]. The feedback from the playtesters on 06/03/2025 was that they found this confusing, and even when it was explained to them it felt unintuitive: they expected them to work in the same way. We tested out two iterations based on this feedback: one was to have Force on all strength levels of both abilities, while the other was to have Force on the first two strength levels of both abilities and Impulse on the third strength level of both abilities. The second option continued to cause confusion, while the first resulted in more clarity. Another example of simplification for ease of use are the iterations on the Sliding Doors. Initially the Sliding Doors were meant to be blocked by a Movable Box so that the players could get past them. However, on the 06/03/2025 playtest, we found them to be more useful and intuitive as simple division between one area and the next.

Simplification for ease of learning. One of our goals for the player characters' controls was to be as concise and intuitive as possible, and as such they went through different iterations along with the player characters' abilities. The first implementation of the abilities allowed players to change the Strength levels of the Single Target mode and of the AOE mode simultaneously, with the third/highest Strength level using Impulse instead of Force for a more immediate push/pull effect. As we iterated on the abilities and how they are communicated to the players we opted for simplification: in the final version the two modes' Strength levels are connected, meaning that the players always increase and decrease both at the same time, and they are both communicated through the same visual indicator placed on the player character. This meant that the buttons needed to use the player characters have been reduced in number, thus simplifying the control schemes. Additionally on the 25/03/2025 playtest we noted that one of the playtesters explained the controls to the other, and overall the image used for the control schemes was not clear. This indicates that we need to create a control scheme picture that is simpler and more readable.

[19] ***Single Target Mode.*** One of the two modes of the player characters abilities where the player characters Pushes/Pulls only the targeted Movable Object.
[20] ***AOE Mode.*** One of the two modes of the player characters abilities where the player characters Pushes/Pulls all Movable Objects within range.
[21] Force in Unity adds a continuous force to the object's rigidbody (for rigidbody see footnote 10), using its mass (*ForceMode.Force*, n.d.).
[22] Impulse in Unity adds an instant force impulse to the rigidbody (for rigidbody see footnote 10), using its mass (*ForceMode.Impulse*, n.d.)

Simplification for clarity of visual language. Three sections of our demo are made of challenges that require players to move a Key-Activate[23] to a Pressure Plate[24] in order to open a Triggered Door[25] that will open the way to the next session. The first iterations of the Key-Activate varied in shape, some being cube-shaped while others sphere-shaped. Most of the Key-Activates are also Movable Objects[26], while one requires the players to move the environment around it to make it travel from point A to point B. However, in later iterations we identified two reasons to reduce the variations and have all of them be sphere-shaped. The first is that a cube shape in a 3D platformer suggests players to use them to build platforming paths to jump onto, while a sphere-shape is less so (even if it does not prevent the players from trying to use the object creatively). The second is that having all Key-Activate objects spherical, regardless of whether or not they are Movable Objects, creates consistency in how we communicate the function of each object to the players, thus following the principles of "Intuitive interactions between players and environment: it should always be obvious what effect an action will produce" and "Creating an environment that communicates to the player in an aesthetically cohesive manner" [section 2.1.2.1.].

Simplification for making the level design more concise. During the 27/03/2025 we noted down which sections of the grayboxed level performed better with regards to cooperative play and which ones performed poorly. Since our demo needed to be 15 min long, we removed the sections that underperformed and shortened others that had redundant interactions.

3.2.5.3. Opportunistic iteration

As explained in the *Design Framework* chapter, opportunistic iteration consists in using iteration to find and explore new ideas through experimentation. We found opportunistic iteration to be a useful ideation tool. We created one playground scene where designers could test out different interactions and explore questions like:

- How do the player characters' abilities interact with objects of different shapes, sizes and weights?
- What happens when the players jump on a bouncy surface? When they drop an object on a bouncy surface?
- Etc.

It also allowed us to try out simple design ideas before designing an entire level's section around it.

[23] ***Key-Activate.*** An object that activates something when put on a Pressure Plate.
[24] ***Pressure Plate.*** An object that activates something when a Key-Activate is placed on it.
[25] ***Triggered Door.*** A door that opens while a Key-Activate is on a Pressure Plate and closes when it isn't.
[26] ***Movable Object.*** An object that the players can move with their player characters' Push/Pull abilities.

3.2.5.4. Iteration as elaboration or refinement

During the development of our demo we used iteration as elaboration or refinement to give better feedback to the player's actions, to make some interactions easier to use and to give more utility to underused features.

Refinement for fine-tuning game feel. Game feel consists in players' experience of controlling the player characters and other objects in the game (Swink, 2008). Often the iterative process of fine-tuning the values of different gameplay elements to achieve a specific game feel falls into the category of iteration as refinement. An example of iteration as retirement in the development of our demo has been the fine-tuning of the player characters' movement and abilities, of Unity's physics settings, and of the mass and damping of the Movable Objects. These are all elements that in combination contribute to the game feel for the demo. The player characters needed to be neither too slow nor too fast, the jump needed to look natural while still allowing the player characters to move from one platform to the other, the Movable Object needed to seem as light or as heavy as their visual representation hints at while still being controllable enough to be manipulated by the players without frustration, and so on. The process of adjusting all the values that contribute to the game feel is an iterative process that requires noting down the combinations of values tested and the result of the test.

Elaboration for clarity of visual language. During the accessibility and usability playtests the only indication of which object the players were currently targeting was a change in the target's color. One problem that we already knew going in is that this did not allow us to differentiate between objects targeted by the Push Player and objects targeted by the Pull Player, which was indeed an issue encountered by the playtesters. While playing, all playtesters noted that it would be nice to have a line going from the player to the targeted movable object, so that it is clear which player is targeting what. This would also indicate the max range. Additionally in *Playtest A* we noted that it would be more clear which line belongs to which player through color coding.

Elaboration for ease of use. During the accessibility and usability playtests, we observed that the playtesters had issues with keeping the Key-Activate on the Pressure Plate, so we changed the level design so that the Key-Activated would be slotted in place.

Elaboration to give utility to underused features. As noted down by the designers while analyzing the first three levels prototyped during the accessibility and usability playtests, there wasn't any use for the AOE ability and the players noticed it. We thus decided to take the time to design and prototype simple challenges that would use the AOE ability. Additionally, in *Playtest A* and *Playtest B* it was noted by the playtesters that they felt like the Pulling ability was more useful than Pushing, so we set out to iterate on the level design so that the Push ability would need to be used more. Pulling was also found to be more controllable than Pushing, because when pulling the object,

it is always going to move toward the player, while with Pushing the end point continues to change as the player moves. So, we also iterated on how the Abilities worked, adding a range below which the abilities could not be used, to slightly equalize the controllability. Despite these changes, on *Playtest C* the playtesters still felt like Pulling had more reasons to be used than Push. However, after more general adjustments to the masses and dampening of the movable object this impression was no longer voiced in the *Playtest D* playtest.

3.3.5.5 Iteration within Visual Design

After the initial ideation phase of the visual design, a first round of implementation of the visuals was done. This prompted further iteration on aspects of the style of the visuals, which were applied during the final implementation of visuals into the demo.

The first round of implementation of the visuals happened during the greyboxing phase. During this time the levels were still being changed around, which meant that most of the work of the implementation itself ended up not being used, as those environments got fully re-greyboxed during development. However, during this round of implementation the parts of the process of visual implementation which needed improving were spotted, which allowed for a more streamlined process during the final visual implementation later in the project.

The main element which revealed itself in being needed to be improved was the implementation of textures on the walls and floors. The textures had to be rescaled to fit game object meshes with different dimensions and scales, and it quickly became apparent that this was neither efficient or easy. Hanna looked into different ways to address this problem, and found that using triplanar shaders would address this issue. Triplanar shaders work by projecting a texture onto an object, and allow for textures to retain the same scale and dimensions when applied to game objects of different scales and dimensions. This in turn allows for streamlined and improved looking implementation of textures. Triplanar shaders do not work for every type of game object, as meshes with non box-like shapes will not display the textures correctly. This did not cause any major issues in the project, as most objects that were not box-like were similar in scale and were not abundant.

It also became apparent that the amount of visual decoration would have to be cut down from the initial style test, as the process of applying textures and wall decals was more time consuming than expected.

After going through the first rounds of implementation, a need to simplify the visuals arose. More focus was put on adding additional elements to the environment to further clarify the game space, rather than enhancing the mood of the space. This was done by adding wall and floor trimming to the environments as an addition to the decals being used. The communication aspect was focused on simple 2d tapestry and rug assets Hanna created, by placing said assets on the walls and floors in an attempt to

help bring attention to the players objectives in the game levels. She made multiple tapestry and rug assets, all of which had 6 color variants, as shown in *Figure 67*.

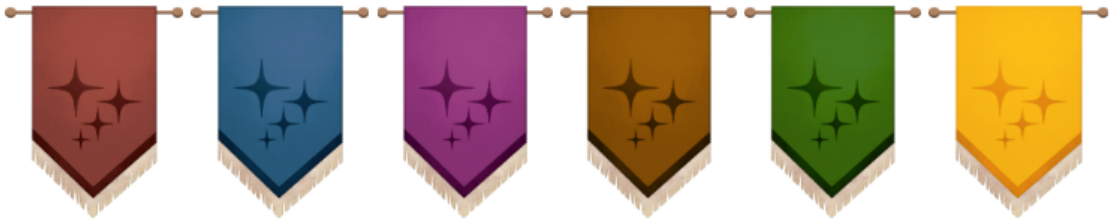


Figure 67. *The different color variants of the tapestry.*

When producing the character model for the player characters, many elements of the initial designs were simplified to match the ability of the team to implement the designs. Some ideas such as adding physics to the wizards' beards went unused, as implementing these elements would have taken more time to implement than we had.

On the second pass of implementation, the focus was on getting the basic elements of the environments in, such as the textures, the decals, and the trimmings. The tapestries and rugs were included as well, and the color of said assets shifted during implementation. Initially they were red, to match the color of the buttons and other puzzle objects during greyboxing, however since one of the wizards was color coded as red, this needed to be changed. Using either red or blue for these assets could have implied connections between said objects and one of the abilities, the new color needed to be unrelated to either. The color selected was yellow, as it was the third primary color, as red and blue are the other primary colors. The final section of the level was greyboxed with green puzzle objects rather than the previous red ones, which was carried into the color used in the final visuals of the game.

Figure 68. *Picture showing Tapestries and Trimmings in the demo.*

There were some issues Hanna faced while rigging the model, and while the crucial ones were fixed, some mistakes left in the weight painting of the model were kept as

they added a level of comedy to how animations appeared on the player characters. The animations themselves are simple, the characters switch between an idle animation and a running animation. The initial goal had been to have visual effects come out of wands the player characters would be holding, however this detail ended up being out of scope for this project.

Figure 69. *Close up of the Player Characters.*

3.3. Description of the demo we ended up creating

The demo that we used to conduct the playtests presented in the *Player Experience* chapter features two player characters and a level divided in six sections.

The two player characters are represented as cartoonish wizards. One is dressed in blue and is able to use the Push ability, while the other is dressed in red and is able to use the Pull ability. Both Push and Pull have two modes, a Single Target mode and an Area of Effect mode. The strength of the Push and Pull abilities both have three strength levels: a low one to have more control over objects, a high one to be able to launch objects or to quickly pull them towards the players, and a medium one for regular movement. Both players are able to move around the 3D environment in all directions and to jump. The player controls are shown in *Figure 70.*

Each of the six sections of the demo's level presents a puzzle or a challenge of skill that the players need to overcome by using their characters' abilities and collaborating with each other. In *section 1* the players need to use a ramp to move a ball from the ground floor to the first floor, where the ball can be placed on a pressure plate that will open the door leading to the next section. In *section 2* the players need to control together a movable platform to be able to jump from one side of the section to the other, if they fail they will fall down to the lower floor and climb back up using a ramp to try again. After that they have to hold a door open for each other to access the next section. In *section 3* they have to use the Pull AOE ability to open two doors at the same time for the Push player, who will walk through them and push a box into the

area where the other player is. They will then need to place the box they acquired and another one in front of two buttons, and use the Push AOE ability to press both buttons at the same time with the boxes to open the door that gives access to the next section. In *section 3* they have to move a ball from the first floor to the second floor and across a door that needs to be held open for it to reach a pressure plate. To move the ball from the first floor to the second floor they have available a movable ramp, a movable cube and three movable platforms, which they can use however they want. By placing the ball onto the pressure plate the players will gain access to the next section. In *section 5* the players have to time the use of AOE Push and AOE Pull to press the buttons in a short amount of time and open the door to the last section. In *section 6* the players need to use Push and Pull to tilt a maze so that the ball can reach the pressure plate and open the door that will lead to the end of the demo. (All sections can be seen in the appendix)

Figure 70. *Screenshot of the control schemes.*

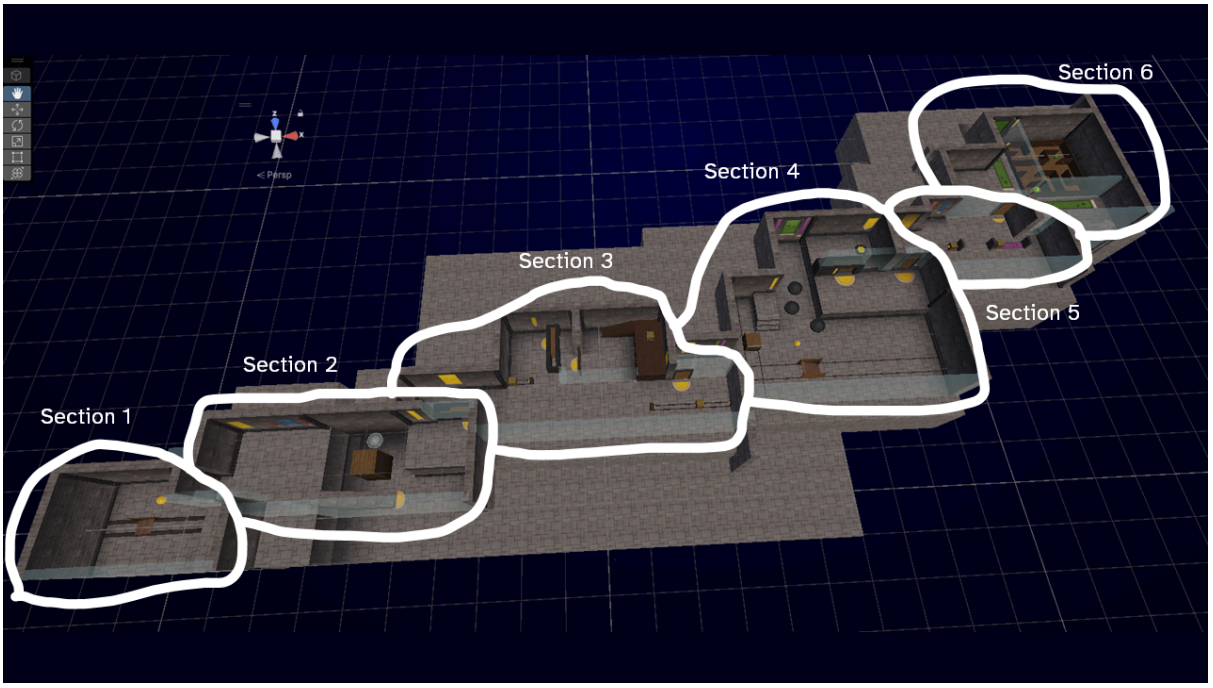


Figure 71. *The demo's level as seen from above in Unity's editor, with the different sections highlighted and labeled.*

3.3.1 Game Visuals

The final results of visual development included textured environments with decorative elements on the walls, textured puzzle related objects, and custom player character models.

Figure 72. *An example picture of The Game Environment.*

The environment was fully textured, with additional decals of translucent fade to back added to the walls and floors to create further depth. Yellow tapestries and rugs were

placed in front of or near player objectives, and were accompanied by occasional purely decorative tapestries.

The puzzle elements were textured as well, and a theme of bright yellow was used for buttons and the objects which were needed to press them. In the final section of the level green was used as well, as an indicator of the final nature of the section.

The player characters received identical meshes, only differing in the colors used in texturing them. The models received rigging and simple animations.

Figure 73. *Close up view of the Player Character Models.*

3.4. Main Takeaways from the Design & Development Process

The design and development of our demo was not only a means of making the demo but also a way to apply our game design principles and methodologies in a practical, team-based context. Through cooperative game design principles and iterative design methods, we reached several takeaways that shaped both our final demo and how we approach collaborative game development.

Cooperative game design principles provide direction. Using cooperative game design principles [*Section 2.1.2.2.*], such as interdependence, complementarity, shared goals, etc.. offered us a good foundational framework during ideation and prototyping. However, these game design principles are most effective as guiding values rather than strict constraints. As an example we have the game design principle about complementarity, as mentioned above, that helped define our push/pull mechanics and the asymmetric player roles, but the implementation required continuous

adaptation based on level design needs, technical limitation, and player feedback during testing.

Simplicity breeds cooperation. One of the most impactful challenges we encountered was balancing the mechanical complexity with intuitive cooperation. This is represented best in our early prototypes where we experimented with complex combinations of physics and player abilities, however iterative simplification more often than not led to more engaging and cooperative scenarios. By reducing mechanical and visual noise helped to highlight the interactions that led to interdependence that we wanted, while making it easier for players of differing game literacy levels to play our demo, which was one of the design principles that functioned as a goal for us to move towards.

Design documentation and communication tools are crucial. Since we set for ourselves from the beginning the design principle of "we want to learn how to efficiently communicate information visually", collaboration across disciplines (programming, design, art) was very reliant on visual aids (diagrams, sketches, etc) and structured documentation (diagrams, game loops, etc). Diagramming abilities, level flows, and UI sketches helped us to synchronize our ideas across the team, especially in moments where verbal communication was insufficient. Templates and various visualizations did not only help to facilitate internal collaboration but also helped to clarify for external playtesters the game's systems.

Iteration is complex and rarely linear. As another of our design principles was that of "we want to learn efficient iteration practices", we paid attention to why and how we used iteration throughout the design and development process. Our iterative process was rarely a linear path from early prototype to polished system, it involved multiple types of iteration - simplification, elaboration, and opportunistic adjustment - were the main ones. These iteration types were often prompted by playtest feedback or technical constraints. By recognizing these cases the team was able to respond flexibly, sometimes abandoning and/or repurposing entire mechanics when they failed to contribute to our cooperative game design principles.

Design methods serve the team, not the other way around. While we used a variety of design methods, e.g. sketching, diagramming, external playtesting, and structural ideation. These tools showed the most value when specifically tailored to our team dynamics and goals. The utility of a method was not in its strict rules and guidelines, but in the way it helped us to clarify, discuss, or get insight into our design.

As a whole, these takeaways represent what we have learned by using and applying our cooperative game design principles and design methods in a team-based setting. They also help us to understand how players experienced the demo. In the following chapter, we change from developer-centered reflections to player-centered evaluation, where we explore how these design choices translated into player experiences, behaviours, and strategies during playtesting.

4. Players' Experience

This section goes over the methods used to gather data on the players' experience with our demo, the playtesting protocol used, and the results of the playtests. The results have also been transcribed in the *Appendix*.

4.1. Playtesting Method

To gather data on the players' experience with our demo we used the same methods that we used for the in-development playtests described in the section *External playtests for iterative design: evaluating cooperative gameplay* of the *Design Framework* chapter. To summarize, we used Aghabeigi's Cooperative Performance Metrics (2010) to evaluate the cooperative gameplay by creating a spreadsheet listing the events to observe and by noting down if an event was observed or not as well as in which section of the demo it happened. The differences from the in-development playtests have been in the goal of the playtest and in the demographic of the playtesters: in this final playtest we focused on data that would allow us to evaluate whether or not our demo reflected our cooperative game design principles, and we only accepted playtesters who did not study videogames nor made or wrote about games for a living as suggested by Huguenin (2018).

4.1.1. Playtesting Protocol

We used Huguenin's recommendations (2018) to create a playtesting protocol to follow during the playtesting sessions with the demo, of which we did 14 playtest sessions, with a pair of playtesters per session, over two different days. We did the playtests in a private room at the IT University of Copenhagen which provided us with a big screen for the players to play on as well as ample opportunity to connect our laptops when taking notes. The privacy of the room was also very deliberate, so as to make sure the players would not get disturbed or distracted while playing. Each playtest required at least one team member to conduct the test, along with a playable build and the required peripherals such as controllers. We were able to have two team members to conduct the playtests and one to provide technical assistance on the first day, while on the second day it was just one to conduct the playtest and one for technical assistance. We also made sure to provide an assortment of snacks and water for the external playtesters to make them as comfortable as possible.

For these playtesting sessions, we tested strictly with other students around the university who were not enrolled in the MSc in Games and who did not produce or write about games for a living. This along with the interest in playing cooperative games were the only demographic restrictions imposed by us for the playtests, as we were not interested in analyzing age or gender differences between the playtesters, only how often they played similar games.

The objective of the playtests has been using Aghabeigi's CPMs (2010) to verify how well our demo enables cooperative gameplay. Each playtest took around 15-30 minutes to conduct. We strived to get as close as possible to a sample size of 20, which is what Huguenin recommends (2018): while a smaller number is still usable, a number closer to 20 gives a good chance to recognize possible representative player trends and comments.

The point-for-point protocol itself that we created and followed for the playtests goes as follows:

How to run a playtest:

1. Setup the prototype, water and snacks in the room.
2. Get two external playtesters and at least one team member to conduct the test.
3. Explain what is going to happen to the playtesters: they will play a two-player cooperative game that should last around 15 min, they can stop playing at any moment they want, we will take notes on what happens while they play and then ask them a few questions at the end. After the first playtest we also decided to explicitly tell playtesters that they're free to speak either English, Danish or Italian during the playtesters as we were able to understand all three languages with two interviewers (Laura for Italian and English and Mikkel for Danish and English). The interviews of the first day of the playtests were conducted in English, to allow both interviewers to participate, while on the second day they were conducted in Italian.
4. Explain the controls to the playtesters using demonstrations, like it would happen in a tutorial.
5. Take notes on the observation spreadsheet [*Appendix*] while the playtesters play.
6. After the playtests ask them if they already knew each other before playing and how frequently they play cooperative games, 3D platformers and puzzle games.
7. Then ask the following questions:
    a. "Were there any specific moments where you remember working together to get past an obstacle?"
    b. "Were there any specific moments where the game presented you with an obstacle that you could have overcome just as easily on your own?"
    c. "Were there any specific moments where it felt like the game made playing with someone else something that got in the way of getting past an obstacle?"
    d. Any follow-up question noted down while observing.
    e. "Is there any particular part of the game that you liked?"
    f. "Is there any particular part of the game that you disliked?"
    g. "Do you have any feedback about how you think the game could be improved to be more fun to play together with another player (for you)?"

    It is important to note that before asking these questions we specified that we were seeking feedback on the game, not on the performance of the two

players. Consequently their feedback stayed focused on the game mechanics and the challenges, and not on giving a judgement on the other player's abilities.

8. Thank the playtesters and conclude the session.

The questions asked during the post-test interview have been formulated to give the playtesters opportunity to voice additional feedback about their player experience, allowing us to confront their reflections with the observation data. All playtesters were happy and willing to give both praise and criticism post-testing. When asking if there had been any negative experiences with regards to cooperation, such as with questions b) and c), we made sure to frame them as feedback on what the game presented them with and not on the other playtester. For the playtests of our final demo the first 6 were conducted in English, so that both interviewers could ask questions, while the last playtest interview was conducted in Italian as both playtesters and the only interviewer present were Italian native speakers.

4.2. Playtesting Results

This section goes over the result of the playtests with the objective of describing the players' experience with our demo's cooperative gameplay. The demo is described in section 3.3., but since throughout this section we will be referring to different parts of the level we will give a brief overview here and added screenshots both in this chapter [*Figure 74.*] and in the *Appendix*:

- *Section 1* requires players to get an object from point A to point B by creating a path, using a ramp, for the object to be pushed on the upper floor.
- *Section 2* requires the players to control a floating platform through the use of their abilities to get to the other side of a precipice.
- *Section 3* presents puzzles that require coordination to open various doors, either by using the AOE mode of their ability or by perfectly timing the use of the Single Target mode.
- *Section 4* is a more complex version of bringing an object from point A to point B, which provides a ramp, a big box and various floating platforms to create a path to push/pull the object through.
- *Section 5* requires players to time the use of the AOE mode of their abilities to open a door.
- *Section 6* presents the player with a maze that has a ball that needs to go from point A to point B. The players cannot control the ball but they can control the maze by tilting it with their abilities.

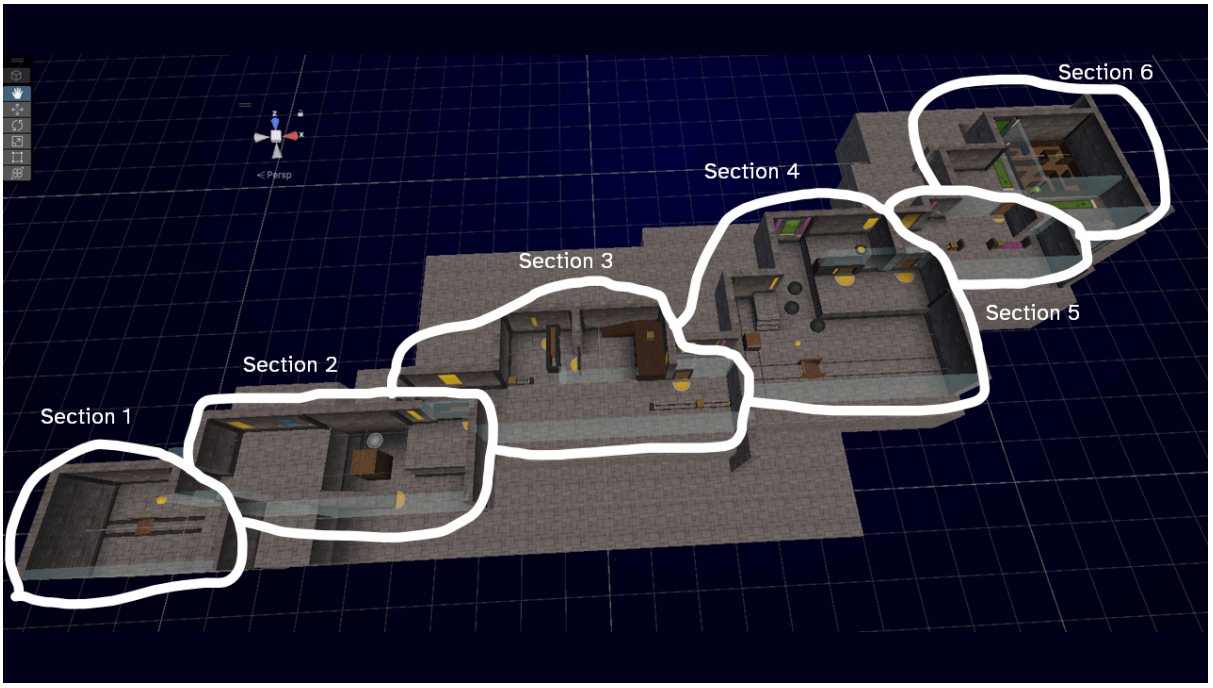


Figure 74. *A screenshot of the demo's level from above in Unity's editor, with the different sections highlighted and labeled.*

4.2.1. Playtesters' experience with similar games

Number of sessions and playtests. We conducted seven playtesting sessions with a total of fourteen playtesters, which falls short of the recommended number for those types of playtests (Huguenin, 2018), but still provided us with the variety of playtesters pairs that we needed. Before initiating the demo itself we found it an important metric to measure each player's familiarity with the genres that our demo touches on. A player's experience with a genre can have a large influence on their performance and potentially their enjoyment of it as well. Similarly, it gives us the ability to focus on data and feedback from those who are most likely to play the game in the long run (Huguenin, 2018).

Frequency of playing similar games overall. Most of the playtesters have had previous experiences with cooperative games and 3D platformers, with only one (7,1%) having no previous experience with both of those genres, as shown in *Figure 75.*, *Figure 76.*, and *Figure 77.* With cooperative games the majority of playtesters either play them at least once per week (35,7%, meaning 5 of them) or at least once per year (21,4% meaning 3 of them). While for 3D platformers most of them played less frequently than once per year (28,6%, meaning 4 of them), at least once per year (21,4%, meaning 3) or at least once per month (21,4%). The frequency to which the playtesters played puzzle games was a bit more diversified: most of them have had experience with similar games, but the frequency was more varied, as shown in *Figure 77.*

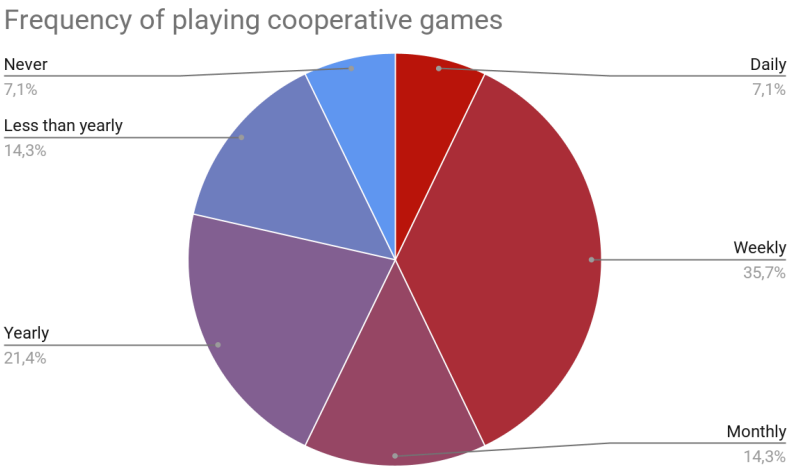


Figure 75. *A graph representing the frequency to which our playtesters play cooperative games. 37,7% (5) of them played them at least once per week, 21,4% (3) at least once per year, 14,3% (2) at least once per month and another 14,3% (2) less frequently than once per year, 7,1% (1) at least once per day and another 7,1% (1) had never played this genre of games.*

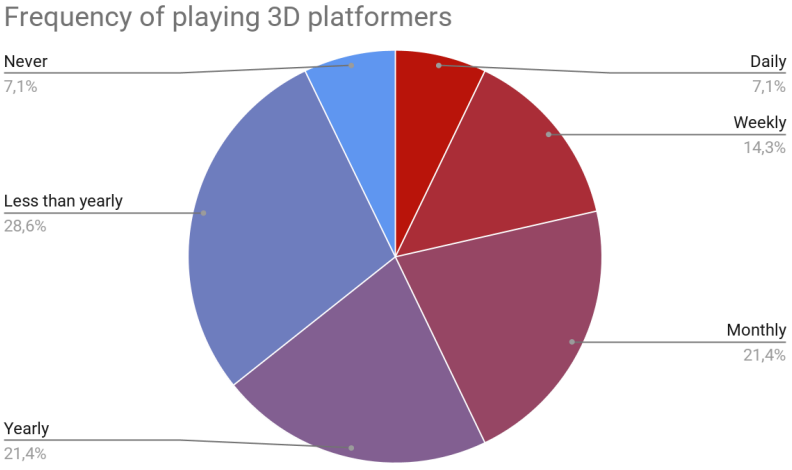


Figure 76. *A graph representing the frequency to which our playtesters play 3D platformers. 28,6% (4) of them play less frequently than once per year, 21,4% (3) of them play at least once per year, 21,4% (3) of them play at least once per month, 14,3% (2) of them play at least once per week, 7,1% (1) of them play at least once per day and 7,1% (1) of them never played this genre of games.*

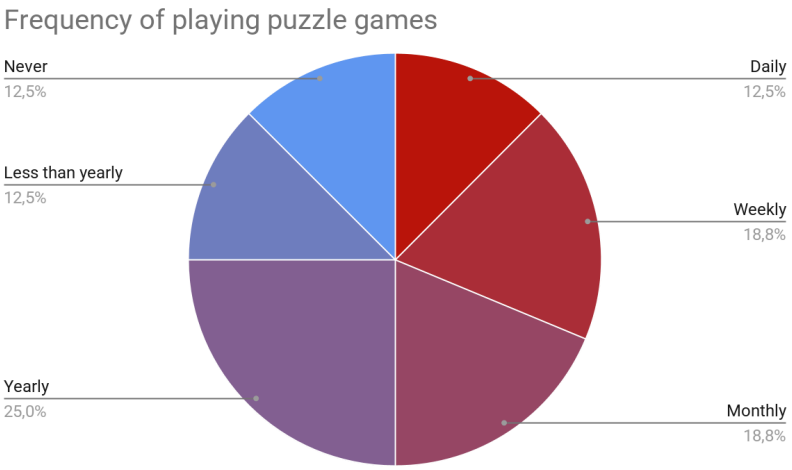


Figure 77. *A graph representing the frequency to which our playtesters play puzzle games. 25% (4) of them play at least once per year, 18,8% (3) play at least once per month, 18,8% play at least once per week, 12,5% (2) never played this genre of games, 12,5% (2) play less frequently than once per year and 12,5% (2) play at least once per day.*

Pairing playtesters with different frequencies of play. As shown in *Figure 78.*, and in the *Appendix*, most of the pairs of playtesters played the same genres of games with similar frequency. Consequently, in this chapter and in the *Analysis* chapter we will be able to discuss only a few cases where the frequency of play between the two players was different. We took note of this data because one of our design principles has been to make a game that was enjoyable for players of different experience levels, and because it is not unusual for players of two-player local cooperative games to play with a player who is more or less experienced than them.

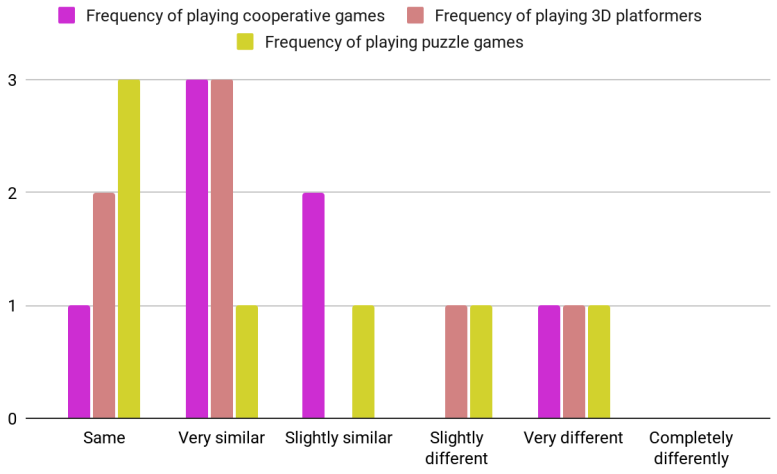


Figure 78. *A graph representing how big was the difference between the players in each pair with regards to the frequency of play of similar genres of games.*

4.2.2. Enjoying the game together

While observing the playtesters we noted down if:

- The playtesters laugh at the same time at a specific game event, ignoring instances where only one player laughs without the other (Aghabeigi, 2010).
- The playtesters express verbally that they are enjoying the game (Aghabeigi, 2010).
- The playtesters show facial expressions and other nonverbal behaviors that clearly express happiness or excitement (Aghabeigi, 2010).

These events were labeled as “Laughter and excitement together”, a metric that Aghabeigi validated to measure the enjoyment of the cooperative player experience.

In Playtest 1 we noted that there was little communicativeness despite the two playtesters knowing each other as they are working on a project together. We observed that the less experienced playtester of the pair, Push_1, struggled with the game while the more experienced one, Pull_1, only occasionally helped with some explanations. The only moment where they shared laughter and excitement together was in the last section of the game, as they acquired a good understanding of the gameplay.

After the playtest Mikkel (Game Designer) asked if they would have been more communicative with each other if we had told them that they could speak with each other in Danish instead of English and they said yes. Consequently, in the other playtests we told the playtesters that they could speak either English, Danish or Italian, whichever language they felt most comfortable with. The playtesters from Playtests 2-6 played mostly in Danish and occasionally in English, sharing the same language, while Playtest 7 was conducted in Italian.

After this change in the playtesting protocol, all following playtesting sessions resulted in all pairs laughing at the same events together and showing facial expressions and other nonverbal behaviours that clearly expressed excitement. It was less common for playtesters to express verbally that they were enjoying the game as they played the game, even in cases where they said to have enjoyed the game when asked what they liked and disliked about it.

From both our observations and our follow-up questions to the players we noted some positive results:

- Push_2&Pull_2 and Push_4&Pull_4 verbally expressed satisfaction at the completion of puzzles and at good coordination.
- Push_3&Pull_3 expressed enjoyment while fooling around with their abilities and the movable objects.
- Push_5&Pull_5 and Push_6&Pull_6 said “that was very fun” and similar phrases unprompted.

As well as some negative results:

- Pull_3 did not enjoy the feel of the jump.
- Push_6&Pull_6 and Push_7&Pull_7 expressed some frustration with the camera, as it did not allow them to split without one of them being unable to see what they were doing.

It can thus be noted that the expressions of frustrations are tied to unpolished game feel and with the camera that does not combine well with the more open areas. While the expressions of enjoyment are about cooperating and fooling around together.

We also noted down which sections players clearly expressed enjoyment, or that they clearly stated having liked or disliked [*Table 4*]. Most of the laughter and non-verbal expressions of having fun came up while the playtesters were figuring out the game together, with *section 2* being one where the mechanics usually clicked. *Section 3* and *section 4* were appreciated as puzzles, but the absence of a split-screen compared with a more spacious area caused frustrations. The maze was also appreciated as a puzzle by a good number of playtesters, but the difficulty in seeing clearly what happened and unclarity in how to control it also created frustrations.

	Playtest 1	**Playtest 2**	**Playtest 3**	**Playtest 4**	**Playtest 5**	**Playtest 6**	**Playtest 7**
Section 1	-	Enjoyed	Enjoyed	-	Enjoyed	-	-
Section 2	-	Enjoyed	Enjoyed	Enjoyed	Enjoyed	Enjoyed	Enjoyed
Section 3	-	Enjoyed	-	-	Enjoyed	Enjoyed	Not enjoyed
Section 4	-	Enjoyed	-	Enjoyed	Enjoyed	Enjoyed	Not enjoyed
Section 5	-	-	-	-	Enjoyed	-	-
Section 6	Enjoyed	-	-	Not enjoyed	Enjoyed	-	Enjoyed

Table 4. *A table showing which sections of the demo have been enjoyed or explicitly not enjoyed by the playtesters. Sorted by playtest session along the horizontal and level section along the vertical.*

Overall the game was enjoyable both by pairs that presented different and similar frequencies of playing different games. It is an unfortunate shortcoming that we had not considered saying to the first pair of playtesters that they could speak in Danish while they played, as it did not allow us to see how two people that had very different frequencies of play (one on a daily base for all similar genres of games and the other on less than a yearly basis) would naturally interact with each other while they played. However, the last playtest was done with players who had slightly different frequencies of play with regards to both 3D platformers and puzzle games, and they also mostly expressed enjoyment of the overall experience.

4.2.3. Worked out strategies

While observing the playtesters we also took note of whether or not:

- The playtesters talk aloud about solving a shared challenge(Aghabeigi, 2010).
- The playtesters navigate the world while consulting with each other (Aghabeigi, 2010).
- The playtesters show pre-planned gameplay behaviour that emerges in similar cases (Aghabeigi, 2010).

We did not include the fourth item used to measure this metric, "The playtesters divide the game zone into different parts in order to divide and conquer", because it was not relevant to the type of gameplay that we designed and implemented.

We observed that all playtesters have cooperated together to progress through the demo's level to a good degree, even the first pair who struggled with communication for the reasons previously mentioned. All of them talked about how to approach the challenges presented to them and most of them navigated the level while consulting each other. Most of them did not show pre-planned behaviour that emerged in similar cases, the gameplay styles tended to be more experimental and freeform than strategic, although Push_2&Pull_2 always made references to previous puzzles and their solutions when encountering new ones.

We also noted the following positive results:

- Push_2&Pull_2 had never met each other and yet the demo seemed to facilitate a lot of cooperation between them.
- Push_2&Pull_2 and Push_4&Pull_4 explicitly expressed the feeling that their abilities and roles were complementary.
- Push_4&Pull_4, Push_5&Pull_5 and Push_7&Pull_7 commented that the challenges made them work together.
- Push_6&Pull_6 had a lot of moments where they scoped out the room and ask "how do we do this?".
- Push_7&Pull_7 always tended to first explore new areas separately and then rejoin to figure out how to solve the challenge.

And some negative results as well:

- Push_1 struggled with understanding the game's controls and how to play in general, which made it more difficult to participate actively in the cooperation, apart from section 6 after gaining a good understanding of how to play
- The main obstacle to collaboration was the camera not allowing them to move more independently in the more open areas.

As seen in *Table 5.*, the sections where the most active cooperation occurred were *section 1*, presumably because it's the first one where they have to learn the game together, and *section 4*. *Section 2* and *section 3* performed quite well too in enabling cooperative gameplay. Despite not performing as well in cooperation as other sections, *section 6* was one of the few that the players distinctly recalled as having

liked to cooperate to solve it. *Section 5* is quite short and intuitive and does not require a lot of talking about how to solve it.

	Playtest 1	Playtest 2	Playtest 3	Playtest 4	Playtest 5	Playtest 6	Playtest 7
Section 1	Coop	Coop		Coop	Coop	Coop	Coop
Section 2		Coop	Coop	Coop		Coop	Coop
Section 3	Coop	Coop		Coop		Coop	Coop
Section 4	Coop	Coop		Coop	Coop	Coop	Coop
Section 5	Coop					Coop	Coop
Section 6	Coop			Coop		Coop	Coop

Table 5. *A table showing which sections of the demo have enabled explicit discussions about how to play cooperatively the most. Sorted by playtest session along the horizontal and level section along the vertical.*

With regards to the pairs that were composed of people with different frequencies of play of similar games, Pull_1 as the most experienced player explained to and guided a lot Push_1 who had very little experience with videogames in general, while Push_7&Pull_7 figured out how to solve the puzzles together even if Push_7 played both puzzles and 3D platformers more frequently.

4.2.5. Global strategies

The metric of "global strategies" refers to events in which playtesters take different roles during gameplay that complement each others' responsibilities and abilities (Aghabeigi, 2010). While Aghabeigi specifies that this parameter considers "the number of times the people change their roles, which high values shows players are interested in different dimensions of game-play, and low values represents the minimum effort for looking at a game from another perspective". The players here could not change their roles, but they did have two distinct roles: one pushes objects while the other pulls them. We thus focused to note down situations in which the players talk about taking different roles when discussing how to complete a challenge, with specific references to their roles.

We were able to note that 71,4% (5) of the pairs of playtesters used their abilities to take different and complementary roles during their sessions, while for the other 28,6% (2) this was not visibly the case while observing them play. Most of the explicit assignment of roles happened in sections 1-4. Push_1&Pull_1 while taking on different roles mechanically did not discuss it much, while Push_3&Pull_3 struggled to see how they could help each other by using their different abilities and continued to try to do it alone, although at the end they figured it out and this unlocked cooperation.

In *Table 6.*, we noted specific sections in which the playtesters have discussed their abilities and roles as part of cooperation while playing and one where they specifically did not do so. Unmarked cases are because there weren't any specific events, but there was a more global attitude to not discuss them (Playtest 1) or it only came up to a minimal/less explicit extent in discussion even if they still cooperated through different roles (Playtests 2-5).

	Playtest 1	Playtest 2	Playtest 3	Playtest 4	Playtest 5	Playtest 6	Playtest 7
Section 1	-	-	-	-	-	Discuss roles	Discuss roles
Section 2	-	Discuss roles	Failed to discuss roles	Discuss roles	-	Discuss roles	Discuss roles
Section 3	-	-	-	-	Discuss roles	Discuss roles	Discuss roles
Section 4	-	-	-	-	Discuss roles	Discuss roles	Discuss roles
Section 5	-	-	-	-	-	Discuss roles	Discuss roles
Section 6	-	-	-	-	-	Discuss roles	Discuss roles

Table 6. *A table showing which sections of the demo have enabled discussions of how to use their different roles. Sorted by playtest session along the horizontal and level section along the vertical.*

After the playtest, Push_2&Pull_2 commented that they felt complementary to each other, even if at the beginning Push_2 did not realize that they had different abilities until Pull_2 pointed it out. Push_4&Pull_4 also noted that they liked how the mechanics were designed to encourage teamwork. Push_6&Pull_6 instead tended to forget that they had different abilities. Overall, the two roles can be seen as similar because both involve moving objects, even if it is in opposite directions, but most of the playtesters recognized them as having their own function in different challenges.

There aren't noticeable differences in this regard between pairs of playtesters that present different frequencies of play of similar games.

4.2.5. Helping each other out

While the previous two sections were about positive metrics, meaning events that if they occurred are an indicator of the demo performing well as a cooperative game, the players helping each other out can either be a positive or negative metric depending on the context. This metric refers exclusively to events in which one player helps or guides the other, not when they are helping each other at the same time. It is not necessarily negative if a player struggles with controlling their character and abilities in

the first section of the game and the other helps them, but if it continues to happen throughout the whole demo it is a sign that the abilities are too difficult to understand. Similarly, if the players who have played similar games less frequently are often continuously guided throughout the demo it is also a sign that the game design does not allow them to be active participants when there is a disparity in the frequency of play.

We thus noted down if:

- The playtesters talked about controllers, and how one can use the game mechanics (Aghabeigi, 2010).
- The playtesters told each other the correct way of passing a shared obstacle (Aghabeigi, 2010).
- The playtesters saved and rescued the other player while they were failing (Aghabeigi, 2010).

Some extent of helping each other out has happened in all the playtesting sessions. As shown in *Table 7.*, most of the explanations about controls happened in *section 1* and *section 2*, with *section 3* being the latest that required one player to explain the controls to the other. There have been situations where one player had to stop to explain a correct solution to the other up to *section 4*, with most cases in sections 1 and 2. There have also been two occasions where one player had to help the other to prevent them from failing at what they were doing.

	Playtest 1	**Playtest 2**	**Playtest 3**	**Playtest 4**	**Playtest 5**	**Playtest 6**	**Playtest 7**
Section 1	Controls	Controls Solution	Controls Solution	Controls Prevent fail	Controls	Controls Solution	
Section 2	Solution				Solution	Controls Solution Prevent fail	Controls Solution
Section 3	Solution	Controls					Solution
Section 4				Solution	Solution		
Section 5							
Section 6							

Table 7. *A table showing which sections of the demo have required one player to help the others outside of the intended cooperative experience. Sorted by playtest session along the horizontal and level section along the vertical.*

The quantity of events in which “helping the other” events occurred and their distribution through the level was similar regardless of the difference in frequency of play between the players involved.

4.2.6. Waiting for each other

A negative metric to take note of is whether or not there are situations in which one player has to wait for the other to continue while doing nothing (Aghabeigi, 2010). This occurred only in the case of Push_1&Pull_1 in *section 2* and Push_7&Pull_7 in *section 3*, which are both pairs that presented a difference in the frequency of play of similar games. It also happened with Push_3&Pull_3 who have similar frequencies of play of similar games, but contrary to the other situations here the player head was actively communicating with the other to figure out how to reunite in *section 2*. So it happened in a negative way in 28,6% (2) of the playtests, although only in one single instance in both cases.

4.2.7. Getting in each other's ways

Another negative metric is getting in each other's way, meaning situations in which frustration is caused by one player leading and the other lagging behind or by one player wanting to do an action and the other wanting to take a different action, and by taking these actions they interfere or hinder each other's goals (Aghabeigi, 2010). This has happened on two occasions, one with Push_1&Pull_1 and one with Push_3&Pull_3. While waiting for the other player in *section 2*, where one player remained downstairs while the other progressed without aid. The Push_3&Pull_3 instead got intentionally in each other's ways for fun and it was reciprocal because they liked to mess with each other. So this occurred in a negative way in 14,3% (1) of the playtests.

4.3. Takeaways from the players' experience with the demo

The observations and interviews show that the demo enables cooperative gameplay that is enjoyable for people of different experience levels and that players do use their abilities to take different roles when solving challenges. The controls are still presenting some difficulties in being immediately understood. While there have been instances of players lagging behind or getting in each other's ways this is not a frequent occurrence. The main obstacle to cooperative gameplay has been the combination of a camera that does not allow the player splitting with more spacious areas, as well as refining the in-game feel more to give players the feeling of being more in control of their movements and abilities. In future playtests we will focus more on playtests with pairs of players of mixed levels of experience, to have a more comprehensive view of their player experience.

5. Analysis

This chapter provides an analysis of how the cooperative game design principles that we adopted shaped the game design & development process and if the players' experience with our demo reflect these cooperative game design principles.

As a quick recap, the cooperative game design principles that we will go through in this section are the following:

- We want to learn how to design gameplay and game mechanics for local two-player cooperative games.
- Gameplay should support cooperative play.
- Designing for a range of skill levels allows players with different experience levels and makes the game accessible to players with disabilities (Jonassen, 2017).
- The experience should be enjoyable for both players even if they have different videogame literacy levels.
- The game should enable players to have fun with each other.
- The collaboration should feel satisfying for both players together.
- Player character abilities should be asymmetric and equally fun for both players.
- Complementarity between the two player character roles and/or activities (Aghabeigi, 2017). This allows players to take on specialized and inter-dependent roles and avoids allowing one player to do all the work (Jonassen, 2017).
- Creating Synergies between abilities by allowing one player character to "assist or change the abilities of another" and by defining "rewarding rules in a way that consider the performance of all players with different abilities" (Aghabeigi, 2010).
- Having both players interact with the same object (Aghabeigi, 2010).
- Incentivizing cooperative behavior by making it additive to the gameplay and not restrictive (Jonassen, 2017).
- We want to learn how to make dependency on each other feel positive, balanced and dynamic rather than frustrating.
- Presenting players with Shared Puzzles (Aghabeigi, 2010).
- Shared goals that give a reason for the players to work together (Aghabeigi, 2010).
- Encouraging communication and teamwork by allowing players to make choices together and complementing each other (Jonassen, 2017).
- There are three main Camera setting design choices that have been proven successful when developing the camera for cooperative games: "split screen horizontally or vertically, one character in focus, all characters are in focus (the screen doesn't move unless all characters are near each other)" (Aghabeigi, 2010).

5.1. “We want to learn how to design gameplay and game mechanics for local two-player cooperative games”

One of our game design principles centered on the team has been us wanting to learn how to design gameplay and game mechanics for local two-player cooperative games. This principle has of course influenced our design and development process both as a learning objective and as a goal for the players’ experience.

Through our analysis of other cooperative games we learned that there are many ways to approach cooperative gameplay, from giving players complementary abilities, giving them shared resources (Bernard, 2022; Indoor Astronaut, 2019), giving them asymmetric information or asymmetric access to different parts of the world (Hazelight Studios, 2021; Oslo Albet, 2009; tokoronyori, 2023), imposing proximity with each other (Anegar Games, 2024; Coldwood Interactive, 2018; Étranges Libellules, 2008; SandCastles Studio, 2023), providing them with complementary abilities (Hazelight Studios, 2021; Oslo Albet, 2009), allowing them to combine their abilities (Pieces Interactive, 2025), to control the same player character (NEXT Studios, 2020), etc. One of the most common ways is to present them with shared challenges and goals, which is a gameplay element present in all examples that we analyzed. The use of simple game mechanics, or at least of game mechanics that are already commonplace in many videogames and thus likely to be something that many players recognize, is also a design choice that occurs often (Bernard, 2022; DevM Games, 2020; Hazelight Studios, 2021).

Overall, having “learning how to” as a game design principle led us to put a bigger emphasis on testing out our ideas as early as possible, to analyze how the game mechanics, game interactions and levels we made were actually being played by players and in so doing find ways to re-evaluate how we approached things. For example, learning to design shared challenges has been key to learning how to create cooperative gameplay. Designing a challenge that requires the participation of both players in order to be overcome is what brings the players together to coordinate and cooperate, and when testing with external playtesters it becomes evident if a challenge presents design flaws in this regard as it will result in one player removing the obstacle on their own or leaving the other player behind. Additionally, using testing to see if our hypotheses about what would work and what wouldn’t were correct allowed us to spot a disparity in the usability of the two player character abilities, where the Push ability felt less controllable than the Pull ability, and thus made it more likely for players to lean more on the Pull player to move objects around.

The data about the players' experience with our demo reflects what we had learned throughout the process. The players now feel like the challenges require both players in order to be overcome, both player characters feel useful, and while the sense that

push is less controllable is still present, it is felt considerably less strongly than it initially did. The results of the demo's playtest point us to now focus on learning how to implement a split-screen camera, to allow players to move around the larger areas without issue, and a proper onboarding to allow more inexperienced players to be more active participants in the cooperative gameplay.

5.2. "Gameplay should support cooperative play", "The game should enable players to have fun with each other" and "The collaboration should feel satisfying for both players"

One of our game design principles centered on the game itself has been that gameplay should support cooperative play. As a design principle, this is too vague to be a concrete guide during the design & development process, but it is however the base starting point to define the more concrete ones that we will analyze in this section of the analysis. Two other cooperative design principles that are also too vague to guide choices during the design & development process have been "The game should enable players to have fun with each other" and "The collaboration should feel satisfying for both players", which are both design principles centered on the players. However, they were still useful to set as goals for the player experience that, if achieved, indicate that the project is in a good direction as a cooperative game. In that regard from the data gathered about the *Players' Experience* with our demo we were able to verify that the pairs of playtesters have expressed fun and enjoyment for the overall experience in the majority of cases and have stated that what they enjoyed about it was playing together and that completing the challenges and achieving good coordination was satisfying. There are elements of the demo's players' experience that have been reported as not enjoyable, namely the need to further fine-tune the game feel of the jump, have more compatibility with the level design and how the camera is implemented, and better onboarding for more inexperienced players so that they can become more active participants in the cooperative gameplay faster.

The design principles that have guided us better with regards to the how to enable players to have fun with each other and to make the collaboration feel satisfying for both players have been:

- Player character abilities should be asymmetric and equally fun for both players
- Complementarity between the two player character roles and/or activities so that they can take on specialized and inter-dependent roles and avoid allowing one player to do all the work
- Creating synergies between abilities
- Having both players interact with the same object
- Incentivizing cooperative behavior by making it additive to the gameplay and not restrictive

- Presenting players with Shared Puzzles
- Shared goals that give a reason for the players to work together
- Encouraging communication and teamwork by allowing players to make choices together and complementing each other

5.2.2. "Player character abilities should be asymmetric and equally fun for both players"

One of our design principles centered around the players having asymmetric player character abilities that would be equally fun for both players. In the *Design Framework* chapter, we classified this mainly as a game design principle centered on the game, as it is about the player character abilities which are a gameplay element. It is however to be noted that there is also an overlap with game design principles centered on the player, as the intended result is to give an asymmetric experience that is fun for both players.

During the selection of the starting idea for our demo we posed ourselves the questions: "Do the player characters' abilities allow for asymmetric gameplay? Do they allow taking on specialized interdependent roles? Do they allow players to interact with the same object in different ways?". To achieve asymmetricity we decided to ideate and design the game around two physics-based mechanics that would work in opposite ways: the Push ability allows one player to push objects away from them, while the Pull ability allows the other player to pull objects towards them. In retrospective, we can note that the two actual asymmetric elements for the abilities that we have chosen is the direction in which the objects are moved, and the fact that without an aiming system Push gives inherently a lesser sense of control than Pull, because, as mentioned in the previous chapters, it is less obvious where the object will end up. Apart from this, both abilities lean into physics and both players' roles are about manipulating objects.

On paper, the idea was that they would both provide equally enjoyable freeform play with a physics-based gameplay system. Testing our prototype however, revealed the previously mentioned flaw of Push feeling less controllable in its first iterations. In the demo used to gather the data presented in the *Players' Experience* chapter, we addressed this problem in three ways. Firstly, we fine-tuned more the mass and drag of the Movable Objects along with the intensity of the force used for the different strength levels of the ability, so that objects would move slowly enough to be controllable with more precision on a lower strength setting, but still fast enough to give immediate feedback to the players. Secondly, we added a line connecting the players to the object that they are currently targeting in Single Target mode, which helps to see the direction in which the object is currently moving towards. Thirdly, we made it so that both players would be unable to use their abilities on objects that are too close to them, which depowers Pull making it feel closer to the Push's sense of control (or lack thereof).

We did not do more than one session with each pair of playtesters, therefore we don't have the data to check if the same person playing different roles feels like playing with one ability is different while being just as enjoyable as playing with the other. However, from the data presented in the *Players' Experience* chapter, we can note that players remarked on feeling like their roles were complementary. We have observed that the cooperative gameplay provided by the two abilities was enjoyable by almost all pairs of playtesters. Most of the frustrations that came up were not about the player character abilities per se, but rather about the need to have better onboarding and more compatibility between the camera settings and the size of the areas that the players need to navigate.

5.2.2.1. "Complementarity between the two player character roles and/or activities so that they can take on specialized and inter-dependent roles and avoiding allowing one player to do all the work"

Another cooperative game design pattern that we adopted as a cooperative game design principle has been the combination of Aghabeigi's (2010) design pattern of complementarity between the two player character roles and/or activities and Jonassen's (2017) pattern of allowing players to take on specialized and inter-dependent roles and avoiding allowing one player to do all the work.

As mentioned previously, when designing our player characters, we decided from the start that we wanted to assign each player one ability that would complement that of the other player. These principles have guided our selection of the starting idea for our game in the form of questions: "Are the player characters' abilities complementary?" for choosing the pair of player character abilities as well as the question "Does the challenge allow the players to assume specialized and interdependent roles?" to choose which challenges ideas to elaborate into a design.

During the design of the demo's level this design principle shaped the template that we made for designing challenges: for each challenge, the designer would have to answer the questions "How is the Push ability being used to overcome this challenge?", "How is the Pull ability being used to overcome this challenge?" and "How do the players collaborate? Do they combine their abilities? Do they take turns? Etc.".

Despite trying to design the challenges to allow players to take on inter-dependent roles, our first in-development playtests with external playtesters revealed that often one ability had more utility than the other. This prompted us to iterate more on the level design in order to avoid allowing one player to do all the work for the other and make their roles feel more complementary.

When observing the demo's playtesters, we noted that 71,4% (5) of the playtesters did visibly take on different roles. For the most part, this happened wordlessly, without the player explicitly assigning each other roles while talking to each other.

5.2.2.2. "Creating synergies between abilities"

One of the cooperative game design patterns from Aghabeigi (2010) that we adopted as a cooperative game design principle has been the concept of creating synergies between the player characters' abilities by allowing one player character to "assist or change the abilities of another" and by defining "rewarding rules in a way that consider the performance of all players with different abilities".

The question of "Are there synergies between the player characters' abilities" has guided us through the process of selection for our starting idea from the various ones that we had ideated through brainstorming and through the analysis of similar games. Beyond the ideation phase and into the design phase, we made sure to create challenges that would require the players to use their abilities together to move the same objects, like the moving platform in *section 2*[27] or the maze in *section 6*, making it feel rewarding to use their abilities together in synergy. It is however to be noted that the challenges in the other sections of the demo are more about working in turns or moving different objects at the same time, which while it's still about cooperating and coordinating to play together, it does not follow the principles of creating synergies. This suggests that in future developments we might want to lean more into challenges that require interacting with the same object at the same time.

From the playtests that we reported on in the *Players' Experience* chapter, we have noted that *section 2* was the place where the players would usually fully understand the use of the two mechanics, as the players need to move the platform at the same time to control it, while *section 6* was commented on as a moment where they had to coordinate a lot in-real time with each other. In both cases, we can observe that pursuing synergy results in a positive outcome with regard to cooperative gameplay performance.

5.2.2.3. "Having both players interacting with the same object"

Another cooperative game design principle from Aghabeigi (2010), this principle influenced ideation of the player's abilities as well as challenged design throughout the prototype phase. The main guiding question we used in relation to this principle was: "Do players need to interact with the same object to progress?" This helped us make sure that when needed both players would be required to act in coordination with each other, using their abilities to manipulate shared game elements.

This principle was especially prevalent in the tilting maze puzzle in section 6. In that puzzle, the players have to tilt the maze using their abilities so that they get the ball to the pressure plate. However, they only have access to two sides of the maze, making it almost impossible to tilt it in a way that completes the maze alone; this forces players to use their abilities simultaneously, creating a case of enforced shared interaction and interdependence.

[27] All sections can be seen in the *Appendix*.

To support this principle mechanically, we implemented our asymmetric abilities, push and pull, as an application of force on a rigid-body physics object[28]. So, we designed all interactable objects as rigid-body physics objects, this resulted in each player independently applying an additive/subtractive force on the object. This made it so that shared interaction is not a special rule for specific objects but instead the default setting for every interactable object. The game logic applied each player's directional force relative to their position allowing emergent strategies and a sense of cooperation.

While this usually encouraged cooperation, we observed an unintended consequence during early playtesting; some playtesters discovered ways of brute-forcing challenges individually, thereby avoiding the intended cooperation, especially when the challenge did not have strictly enforced joint interaction. From this, we can see that there is a trade-off between encouraging emergent solutions and maintaining interdependent gameplay.

Observing player behavior during playtests revealed that shared object interaction was effective in fostering cooperation. As an example, the floating platform puzzle in section 2 has simultaneous pushing and pulling, causing the platform to rotate or drift. Players were often seen communicating and adjusting their positioning in real-time to navigate it, and these moments reinforced not only functional collaboration but also a sense of shared agency.

In summary, integrating shared object interaction as a core cooperative design principle added significantly to the collaborative dynamic of our game. It helped us design challenges that demanded negotiation, real-time coordination, and mutual effort. But, as our playtests showed us, the presence of shared interaction mechanics is not sufficient to guarantee cooperative play. To fully utilize this principle, it must be supported by challenges that need and reward interdependence.

5.2.3. "Incentivizing cooperative behavior by making it additive to the gameplay and not restrictive"

Another one of the cooperative game design patterns that we included in our cooperative game design principles has been from Jonassen (2017): incentivizing cooperative behaviour by making it additive to the gameplay and not restrictive, so that the players feel like they can do more by cooperating, and not limited for the sake of cooperation.

In our design and development process, this principle has mostly guided our level design process: the challenges have been constructed to be overcome by using the two players' abilities in collaboration. In this case, collaborative behaviour is rewarded

[28] See footnote 11.

by succeeding in progressing with the game and by the positive interactions that the player has with the person they are playing with.

When testing the demo we took note of whether or not players expressed positivity about working together, and we observed if the players got into each other's way or got frustrated by having to wait for the other. Overall, the playtesters expressed enjoyment when they were able to coordinate with each other and when they solved puzzles together. Events in which they had to wait for each other were in the minority, as it happened only to 28,6% (2) of the pairs of playtesters and in both cases it was only one instance. As per getting into each other's ways, this happened only to 14,3% (1) of the pairs of playtesters in a negative way, although we have observed a few cases of players messing with each other playfully in a non-negative way. In most cases, the players felt the presence of the other player to be restrictive in *section 3* and *section 4*, which are larger areas where, if the players split up, the camera would follow only one making it difficult for the other to keep playing. This can be addressed either by redesigning these sections to be smaller, to avoid splitting, or by implementing split-screen, to allow players to split without issues.

5.2.3.1. "We want to learn how to make dependency on each other feel positive, balanced and dynamic rather than frustrating"

Another design principle related to "Incentivizing cooperative behavior by making it additive to the gameplay and not restrictive" was "We want to learn how to make dependency on each other feel positive, balanced and dynamic rather than frustrating", which it's both centered on the team as it was a learning objective of ours, and on the players as it describes a goal for the players' experience. This is another of the principles that is too vague to guide the design & development process directly, but still functions as a goal that can be used to check if the design & development are going in the right direction. Like mentioned previously in this analysis, we noticed that the initial prototype for the Push ability fell short of this goal, and being able to identify it as an issue allowed us to address it as explained in *section 5.2.2.*.

5.2.4. "Presenting players with Shared Puzzles"

This principle as presented by Aghabeigi (2010) emphasizes challenges that need cooperative effort for players to succeed. It guided us through the design process with the questions "Does this challenge require active contribution from both players?". It helped us shape our challenges from ideation and was embedded into our puzzles. As examples we have the tilting maze in *section 6* that can only be solved if both players coordinate, and the timed trigger puzzle in *section 5* that requires near simultaneous activation of the player characters abilities, enforcing spatial and temporal coordination [*section 3.3.*].

Throughout the level design, we prioritized challenges that could not be solved without cooperation. We allowed for creative problem-solving, but required the solutions to

have some form of collaboration between players. This can be seen in testing when some playtesters discovered unintended solutions where one player character can solve the challenge on their own. When this happened it was a question of whether the process of getting to the solution still required cooperation, which it did for most as they discussed it outside the game before it was applied. In those cases, we embrace it as it still holds true to our intended goals of cooperation.

Playtesting showed that players frequently communicated, strategized, and coordinated their actions, even when they did not know each other, as seen in the *Players' Experience* chapter. Many players mentioned that the demo "made them work together", even when one player took the position of leading the other player, the other player acted as a spotter or advisor to the leading player, showing that meaningful cooperation was achieved through the mechanics and social dynamics.

In summary, the principle helped us significantly in shaping our demo's design and was clear in observed player behaviour. By making puzzles that required input from both players, and by embracing emergent collaboration, we achieved meaningful cooperation in both intended and improvised gameplay. This shows that the foundational role of shared puzzles in designing our cooperative experience was strong throughout development.

5.2.5. "Shared goals that give a reason for the players to work together"

One of the principles we utilized was about encouraging players to work together by giving them shared goals.

Cooperative games inherently give players shared goals, as players usually have to work together to reach shared winning conditions. In our case, the focus was on creating a unified level through which players would have to work through chronologically together. These levels were filled with puzzles, which required both players to collaborate to complete. Not only was requiring the use of both players' abilities important to create a feeling of being important for both players, but it also prevented puzzles from being completable by a single person. If a player were to be able to complete the level solo, the players would no longer have reasons to work together beyond prosocial behaviour.

During most playtests, players would work together to reach the end of the level, but a few players would intentionally impair their progression for the sake of comedy. While this did not prevent players from completing the level, it is notable that these players had reasons relating to enjoyment which did occasionally overcome the want to complete the shared goals set for them.

To summarise, this principle is inherently tied to the concept of a cooperative game, however, keeping it in mind during development helped us keep our designs in line with our goal of players being encouraged to work together.

5.2.6. "Encouraging communication and teamwork by allowing players to make choices together and complementing each other"

One of the principles we utilized was about encouraging communication and teamwork between players in making choices regarding the gameplay and working together to complement each other.

To achieve this, we aimed to create gameplay that would require players to work together in a way in which they would be encouraged to communicate with each other. Because of the physics-based gameplay, puzzles could be completed in various similar ways, which would ideally prompt players to communicate their intentions and strategies to each other during gameplay. We considered adding other forms of communication for the players to use, such as emotes, to allow for communication in other forms apart from verbal. However, due to the scope of the project, this was an element which did not make the demo.

To understand whether or not the gameplay of our demo did this was to measure the levels of communication during playtests. We measured how they discussed their roles and abilities, and ways in which puzzles could be solved. We found that players would aid each other in understanding their abilities and gameplay goals, while discussions specifically regarding their roles were less common. In instances where players were separated, they would discuss ways of reuniting. We also found that players felt more comfortable in discussion strategies when speaking in their native languages, as opposed to other shared languages they were not as fluent in.

To summarise, we wanted to encourage communication and decision-making between players by designing puzzles that required cooperation to complete. While we found that players communicated about explaining things to each other, decision-making regarding how puzzles would be solved often happened non verbally. Due to the lower levels of difficulty in the puzzles present, making the need to discuss strategies lower, this principle became less important compared to some of the other principles present.

5.3. "Designing for a range of skill levels allows for players with different experience levels and makes the game accessible to players with disabilities"

This principle aligns with our goal of our demo being accessible to both novice and experienced players. This principle guided our process by prompting us to ask ourselves "Is this mechanic approachable for players with different gaming backgrounds?" and "Do players feel involved regardless of skill?".

In the early prototyping phase of the project, we did not prioritize making sure that the player characters' abilities felt balanced. However during early playtests we quickly found out that the discrepancy was bigger than we had initially believed; the Pull ability was easier to use. The implemented solution, adding a minimum range, made it slightly more difficult mechanically while improving the balance and our intent to support players with different skill levels equally.

How we taught players to play the demo was more reactive than intentional in the end. In the final implementation of the demo we have a menu where the players can view a control scheme for how to control their player character at any time, and we introduced the players to the control scheme before making them play in the playtesting session. However, this control scheme had less experienced players often refer to it, while experienced players adapted quickly. This probably happened because we designed the controls in line with current gaming norms or it might indicate that more experienced players are used to changing around controls by doing so through playing more games, which would explain to some degree the ease with which experienced players picked up the controls. Therefore we can see that there is a gap in our intuitive design where our onboarding could better accommodate players of different skill levels.

As reported in the *Players' Experience*, playtesting showed us that even with our onboarding issues, players with different skill levels were able to have fun together and enjoy the demo. It should be mentioned that communication played a large role once players began to speak their preferred language, where we saw significant improvement in cooperation. Playtesters expressed enjoyment when "figuring things out" a lot, no matter how proficient they were at the mechanics. This shared learning curve reinforced cooperative problem-solving and supported our accessibility goals.

Some design aspects still pose challenges to less experienced players, such as the camera and open areas. This shows that there are still areas where we can improve on our accessible environmental design.

In summary, not every implementation upheld the principle perfectly but the principle still shaped our balancing, informed our usability decisions, and made us reflect on usability throughout the development of the demo. The player experience shows that meaningful cooperation did emerge even between players with differing skill and/or familiarity levels.

5.3.1. "The experience should be enjoyable by both players even if they have different videogame literacy levels"

We wanted to enforce the cooperative nature of our demo by the principle of creating an experience that would be enjoyed by players of varying videogame literacy levels.

Similar to our pursuit of accessibility in relation to disability, we wanted our demo to be understandable and enjoyable for players who were not familiar with games and how they functioned. These players will often be prompted to play together by a more experienced player, meaning that the gameplay we wanted to create had to appeal to a variety of players regardless of skill.

To achieve this, we wanted the abilities the players have to be easily understood, and contribute to the gameplay equally. We designed the player abilities around being simple but engaging, which was more difficult than anticipated. To refine the abilities we had to frequently test them in both internal and external playtests, often tweaking certain values multiple times. Certain aspects of the game were not as understandable as initially thought, such as the concept of being able to move larger objects within the environment. While the playtesters who encountered this issue had higher levels of videogame literacy than most, players with lower levels of literacy may also face the same issue. As players gain more experience with videogames, the players become more familiar with the various actions they can take in various games. Players with lower levels of literacy will not have this knowledge and thus may want to perform actions not possible and not realizing the other kinds of actions which they could take.

During the external playtesting sessions we found that players found enjoyment in using their abilities to interact with the environment and each other, as opposed to just enjoying the completion of goals. This allowed players to enjoy their experience even if they were not fully aware of their gameplay goals. This allowed us to lean into having puzzles with lower levels of difficulty, while still keeping the gameplay enjoyable and engaging.

To summarise, we found that players found enjoyment in interacting with the game, meaning that the lower difficulty of the puzzles presented did not have a negative impact on the players' enjoyment.

5.4. Camera settings choices in cooperative games

As mentioned in *section 3.1.3.1.*, when designing our camera, we based our decision-making on our cooperative game design principles. There are three dominant approaches to camera design in cooperative games (Aghabeigi, 2010): split-screen either horizontally or vertically, a camera with a focus on one player character at a time, or a camera with a focus on both player characters at once. We discussed the pros and cons of each in our early ideation phase [link the chapter] and rejected both split-screen and single-character focus because they did not align with our goal of a shared presence between players. Instead, we chose the shared camera, with a focus on both player characters, which resulted in a camera that followed the midpoint between the two player characters at an angle of approximately 40 degrees.

The cooperative game design principles of shared goals, interdependence, and complementarity directly shaped this choice. By using a single-camera view, we reinforce the notion that the players are acting within the same space, thereby encouraging mutual awareness and problem-solving. Unlike tethered camera systems that restrict player character movement, we designed the environment to be compact, ensuring that player characters remain within a certain distance from each other. This constraint on the player characters' movement supported cooperation without relying on artificial mechanics.

The decisions we made regarding the camera had a direct impact on our development priorities and design strategies. By committing early to a single shared camera, we intentionally designed levels around compact, cooperative areas, thereby ensuring that puzzle elements were close enough together for both players to be visible. It also had an impact on playtests, as we kept a close eye on player character positioning and movement behaviors to see how often and why they left the camera's view. For this reason, we focused primarily on our mechanics and feel, trusting that the camera would convey a shared experience without requiring constant adjustment. On the other hand, this means we ended up de-prioritizing camera controls, which led to problems with framing specific puzzles and guiding the player's attention as effectively.

We were reminded of these limitations during playtesting. Internally, we realized early in our development that the camera was not always fulfilling its intended function of communicating certain things to the player as intuitively as we had intended. However, after some discussion, we decided that it was doing so to an acceptable degree in service of our broader cooperative goals. Externally, players would frequently comment on camera issues, specifically when the camera angle failed to convey the intended puzzle components and solutions. This feedback indicates that we partially failed to communicate the space effectively, which distracted the players from the intended cooperative aspects of our demo.

Despite these issues, the observed player behavior often confirmed our intention; players actively stayed close together, communicated consistently, and solved puzzles in coordination, indicating that the camera did help support a shared cooperative experience. In this sense, the players' experience reflected our cooperative design values to some degree, even if the clarity of interactions was occasionally compromised.

In response, we explored several potential solutions, including dynamic camera splits when players moved too far apart, designer-authored camera triggers for key sections, and even limited player-controlled camera options. In the end, we did not implement these ideas due to limited time and resources, but they remain possible additions for future iterations. In summary, our camera design decisions both reflected and constrained our cooperative goals: it reinforced the spatial unity necessary for shared experiences but also highlighted the challenge of maintaining clarity and guidance in a dynamic cooperative setting.

6. Discussion

This chapter interprets our findings from the previous chapters in relation to our cooperative game design principles, as our research question asked: *How can cooperative game design principles shape game design processes, and how can the player experience reflect these principles?*

Throughout development, cooperative game design principles served as constraints and guides. But, rather than acting as strict guides or as a solution to every problem, these principles framed our design questions and helped us to form our decisions through prototyping. These principles translated well into player experience as explained in the *Analysis*. However, the process revealed the limits of using principles as well: some of them, like "gameplay should support cooperative play", function more as goals than as guides to solve problems, and knowing that our players needed "shared goals" did not tell us how to communicate them to the players [*section 5.2.*].

The successful instances of cooperation we saw in our playtests were almost always a result of game mechanics and level design that enforced reliance on the other player instead of narrative communication or instruction. This suggests that cooperative mechanics should require cooperation and not just allow for it. We also found that simple and intuitive affordances played a large role in whether players could figure out the cooperative intentions that we made. Sections where the layout was unclear or had unclear goals had ineffective communication even when the underlying mechanics supported cooperation. This shows the importance of having both cooperative game mechanics and an accessible and readable level design.

From our players' experience, we found that they do perceive and respond to cooperation in cohort with cooperative game design principles when these principles are embedded into the gameplay. Asreported in the *Players' Experience* chapter, the playtesters voiced their reliance on one another, adopted complementary roles, and had both verbal and non-verbal communication strategies. Even when players were not instructed, these behaviours emerged from our constraints of the design. We also want to make note of the fact that not all cooperative game design principles translated equally to the player experience. Intuitive interaction is frequently mentioned in literature, but we found it hard to measure in experience. While players would adapt quickly more often than not, in the cases where they did not we were not convinced if the issue was with the use of our principle or rather in our implementation of the given feature.

When reflecting back on how we identified and set our game design principles, how we actually used them in our design & development process, if and how they are reflected in the players' experience with our demo, and our analysis, we can now highlight some key takeaways. Firstly, while following the categorization by Kultima & Sandovar (2019) we mainly sorted our design principles between those that are centered on the players and what we want their experience with the game to be like,

those that are centered on the game and what we want it to look and feel like, and those that are centered on the team meaning how we want to work with each other and what we want to learn from the process. From our analysis, it can however be noted that in the practical application of our design principles a more useful categorization would be that between design principles that function as goals, those that are more about a general attitude or approach to how we have worked, and those that function as concrete guides.

Design principles as goals. "The game should enable players to have fun with each other", "The collaboration should feel satisfying for both players together" and "We want to learn how to make dependency on each other feel positive, balanced and dynamic rather than frustrating", as well as the cooperative design pattern of "designing for a range of skill levels allows players with different experiences levels and accessible to players with disabilities", are all design principles that we originally placed in the "centered on the player" category. While that is still true, on a practical side it is useful to categorize them as design principles that function as goals. They are too vague to help us make choices in-the-moment during development, and this is demonstrated by the fact that we have not used them to guide the ideation and design process. However, when testing the game we have to check if the current iteration is achieving these goals, and, if not, evaluate what to do to redirect the design and development of the game towards that direction. The same can be said of "Gameplay should support cooperative play", which is centered on the game, and "We want to learn how to design gameplay and game mechanics for local two-player cooperative games" which is centered on the team. Both of those principles have had the role of goals in our design & development process, not of concrete guides.

Design principles as general attitudes and approaches. There are also design principles that are more about the general attitude and the approach to take while working, such as "Direct, honest, calm and respectful communication: don't hesitate to say when you're encountering problems, need help or when something another team member's work has flaws that should be worked on", "Communicate how your work is progressing to minimize issues with dependencies" and "Respect boundaries about how much and when other team members can and want to work", which are all design principles centered on the team. While these are not design principles that directly shaped any specific design choice or feature present in the demo, they have been fundamental to our own collaborative process [*section 3.1.3.3.*] and helped us to progress pretty quickly and efficiently, to work respectfully with each other, and to always check how our communication could improve. This indirectly allowed us to pursue more efficiently the other design principles that functioned as design goals and guides.

Design principles as guides to make choices. And finally, the majority of the design principles that we set for ourselves served the function of being actual guides either during both the ideation process and the design & development process or just during the design & development process, as shown in [*Table 8.*]:

Design principles that guided both ideation and design & development	**Design principles that guided design & development**
• Complementarity between the two player character roles and/or activities so that they can take on specialized and inter-dependent roles and avoiding allowing one player to do all the work. • Having both players interacting with the same object. • Creating synergies between abilities. • Presenting players with Shared Puzzles. • Player character abilities should be asymmetric and equally fun for both players. • Level design and game mechanics should integrate well with each other. • Game mechanics need to be simple to implement while allowing varied experiences. We want to learn how to design for simplicity of implementation and variety in the player's experience. • We want to learn how to efficiently communicate information visually.	• The experience should be enjoyable by both players even if they have different videogame literacy levels. • The player experience needs to be fun and interesting, not necessarily difficult. • Intuitive interactions between players and environment: it should always be obvious what effect an action will produce. • Encouraging communication and teamwork by allowing players to make choices together and complementing each other. • Incentivizing cooperative behavior by making it additive to the gameplay and not restrictive. • Shared goals that give a reason for the players to work together. • Creating an environment that communicates to the player in an aesthetically cohesive manner.

Table 8. *Table showing which design principles played a role in both ideation and during the design & development phase and which ones played a role only during the design & development phase.*

For example the design principles of complementarity, asymmetricity and synergy between the player character abilities guided both our ideation process and our design process & development process. If an idea or choice went against these design principles, or did not contribute to them or other principles we would change it or discard it, which allowed us to stay focused in our work. Other design principles like having intuitive interactions between the players and the environment or having the experience be interesting but not necessarily difficult came more into play when making choices during the actual design & development process. The design principles that served the function of guides would come from all the categories of design principles that we had initially sorted them in. Principles "centered on the players", like "the experience should be enjoyable by both players even if they have different videogame literacy level" lead us to try to make the controls as simple and as concise as possible." "Creating an environment that communicates to the player in an aesthetically cohesive manner", which is a design principle centred on the game, guided the level design both as a gameplay space and as a visual representation of an environment. And the fact that we wanted to learn efficient iteration practices and how to effectively communicate information visually shaped how we worked on and

communicated ideas and concepts from ideation to design & development. It has to be noted that during the design & development process we had to make compromises with regards to some of these design principles, one important example being "game mechanics need to be simple to implement while allowing varied experiences" with the intention of "We want to learn how to design for simplicity of implementation and variety in the player's experience". The balance between simplicity and the flexibility that allows for variety hasn't been easy to achieve, as explained in *section 3.1.3.2.2.*. When making compromises, we were still able to use our other design principles to decide if we should lean more into simplicity or flexibility: the option that would afford more cooperativeness between the players would be the one picked, which we often found to be the one that focused more on simplifying.

We have applied player-centered design to our demo throughout the process, from the definition of the game's design principles, many of which are centered on the players and function as goals for the players' experience (Fullerton, 2024; Hagen, 2012; Nyblom, 2023), to the inclusion of our observations of their behaviour and their feedback into the iterative design & development of the demo (Sykes & Federoff, 2006; Zimmerman, 2003). Every in-development playtesting session has been informative both with regards to where our current iteration fell short, but also as to what aspects of the iteration lead the playtesters to play cooperatively with each other in interesting ways [*section 3.2.5.1.*]. The other player is at the core of a cooperative play experience, therefore, being informed by the external playtesters' experience allowed us to build onto the aspects of our iterations that enabled both players to actively participate in the cooperative play. After the development of the demo, the players remained a central part of our overall thesis project as it gave us the data needed to check if the design principles that we set for our game were reflected in their experience of the demo [*chapter 4*]. From our *Analysis* we can conclude that most of our cooperative design principles are reflected in the players' experience with our demo. The Push and Pull abilities at their core are less complementary, asymmetric and balanced than what we initially thought, which prompted us to iterate both on how we had implemented them and on the level design to be closer to those design principles. We successfully designed a few challenges in which the players have to synergize in real-time, which indicates that we can continue building onto that so that future iterations reflect that design principle more. In future playtesting sessions, we should put a stronger focus on gathering data on the players' experience of playtesters who have a higher difference in skill level between them, and we should have sessions in which the playtesters switch roles to check if both of them enjoy or dislike the experience to a similar degree in both roles.

Researching similar games during the ideation phase is common practice in game design (Bernard, 2022; Kultima, 2010). We used the research of similar games both as a tool to define our cooperative game design principles (e.g., asymmetry, complementary, simple controls, etc.) and to ideate on pairs of abilities for our player characters [*section 3.2.1.1.*]. Researching options for the various visual styles was focused on expanding on basic ideas which had been gathered during initial ideation.

This research was also influenced by the constraints of the project, as well as the design principles guiding it. The results were a moodboard from which sketching was conducted from, which in turn allowed for iteration on the visual style to occur.

Like the designers interviewed by Kultima (2010), we have also used divergent ideation aka brainstorming as an ideation technique both in previous projects and in this one. In the context of ideation, we found that having already pre-established the project's game design principles was useful for structuring the ideation process and to have a faster idea evaluation and selection process. We already knew that we wanted to have complementary and asymmetric abilities for the player characters, and that we wanted our level design to provide situations where the players would need to cooperate, which allowed us to brainstorm while still being focused on specific objectives. These same principles also provided us with clear and pre-agreed upon parameters through which to evaluate the brainstormed ideas. Laura (Game Designer) in particular noticed that this allowed us to move from ideation to the initial design phase much faster compared to previous projects of a similar size that they had worked on, in which there had not been an effort to define the project's design principles in beforehand.

Like the game developers interviewed by Kultima (2015), we have chosen an iterative approach to the design and development of both our demo's gameplay and visual design. As we pointed out in our takeaways from the *Design & Development Process* chapter, each round of iteration was prompted mainly to resolve issues brought up by either technical constraints and player feedback, or by analyzing which aspects of the previous iterations succeeded in reflecting our game design principles in the playtesters' player experience. Through the development process of the demo we also found it useful to apply iteration not just to the game, but also to how we used the design methods presented in the *Design Framework* chapter, for example by adjusting the format of diagrams, templates, etc. to tailor them to what worked better as references for the rest of the team. Iteration was also used to refine the style and implementation of the visual design. The iteration on the style of the visual design allowed for exploration in a controlled manner, which allowed us to find a style and create assets which suited the constraints of the team as well as the cooperative principles we were designing around. Iteration also facilitated the improvement of the implementation of the visual style, as we realized the process itself required reorganizing during the project.

We have seen from the literature review done to construct our *Design Framework* that diagramming can be used as a design tool for gameplay, level design and user interfaces (Adams, 2009; Almeida & da Silva, 2013; Byrne, 2005; Dormans, 2012; Librande, 2010; Neil, 2012; Taylor et al., 2006). During our design & development process, we found ourselves using diagramming as a design tool to explain game mechanics, how players would navigate and interact with specific sections of the level and the overall pacing of the level design, what the overall game loop would be as well as how the players would navigate the user interface. From a design perspective, we found them to be a versatile tool and a vital reference to have during team discussions

with other gameplay designers and our tech lead. From a programmer's perspective, diagrams are useful as well as they make it easier to grasp game design concepts and know in which context a mechanic would be used and how it interacts with the overall system. We often used diagrams as components of more comprehensive design templates, which would also include sketches to further illustrate what was being explained through the diagrams, thus giving more context during the implementation of the design. During the development of the visuals, sketching was useful in exploring ideas for the visuals of the environments and other game assets. At the beginning of development, these sketches mainly served to visualise possible overarching visual styles. As we had decided to use premade assets, there was no need to sketch specific designs for the environments. The only assets that needed custom designs were the player characters. Because of this, further sketching was done to refine their designs. The final drawings were used as the base from which the 3D models of the player characters were built, and informed the ways in which certain aspects of the assets were to be textured.

Overall, from a gameplay design perspective, templating with the inclusion of diagrams and sketches are valuable tools to overcome the difficulties of the passage from design documentation to prototyping that Neil (2012) had pointed out. We find it important to highlight that the utility of these design methods relies on the ability of tailoring them to each team's dynamics and goals, similarly to how different projects are aided by the development of customized development tools. A design method, such as templating, diagramming, and sketching is effective when it succeeds in communicating concepts across disciplines and when it aids interdisciplinary discussions by functioning as visual references.

In conclusion, game design principles can play the role of goals for the player experience, attitude that the team wants to adopt while working, or as guides to reference when making choices during ideation and the design & development process. The link between the design principles that the team intentionally set for the project and themselves is observably reflected in the players' experience with our demo. We found player-centered design to be a valid complement to iterative design, as it requires us to check-in with the players' perspective throughout the development process from prototyping to demo. Additionally, iteration is an approach that provides a common ground between the designers, programmer and artist that worked on the demo, as it is familiar to all three disciplines. Always on the topic of working with an interdisciplinary team, diagrams and sketches also provided a common language between designers and programmers, artists and designers and programmers as well as designers and artists. Additionally, we found design tools such as templating, sketching and diagramming to be most useful when they are tailored to the team working on the project. It is thus important for game designers to become skilled in adapting the way they use these tools based on the feedback of the colleagues whouse them as references to work from.

7. Conclusion

Our thesis' objective has been to contribute to the existing literature by providing a report and analysis on the application of game design methods and on the use of game design values to guide the design & development process, a type of research that Almeida & da Silva (2013) and Kultima & Sandovar (2019) had noticed being lacking. Our focus has been specifically on game design principles for two-player local cooperative videogames, which led us to place emphasis on the necessity of a player-centric approach throughout the whole process.

As Kultima & Sandovar (2019) explain, game design principles originate from the value systems of game developers. Therefore, we defined our design principles by discussing design values that we wanted to apply as a team and to our game. While this can be done by each team on their own, our advice would be to first look into pre-existing work on the topic of design values, either by other developers or by researchers like Kultima & Sandovar (2019), as this will provide an informed starting point for these discussions. At the end of this process, we created a list of design principles, that include some of the values discussed in Kultima & Sandovar's paper (2019) as well as the cooperative design patterns identified in papers by Aghabeigi, (2010) and Jonassen (2017) and a few of our own [*section 2.1.2.1.*].

In the *Discussion* chapter, we have pointed out that design principles can serve three different functions: they can be goals for the game and player experience, they can be attitudes that the team wants to adopt while working on the project, and they can be practical guides that help when making choices during the design & development process. Additionally, having some predefined design principles as a reference is a valid tool to support the evaluation of ideas during the ideation phase. A practical suggestion of ours would therefore be to distinguish between these different types of design principles before the ideation phase, so that it is clear from the beginning which role they will take while designing, developing and testing the game.

From our *Analysis* we can conclude that intentionally applying these cooperative design principles to our design & development helped us to work effectively with each other on our demo and made it so that they would be reflected in the players' experience of the demo, thus bringing closer our intended player experience to the perceived player experience.

With regards to the use of tools to reason about and visualize game mechanics (Nelson & Mateas, 2009), in our process diagramming and sketching have proved to be essential and versatile tools for cross-disciplinary communication and to aid the passage from game design documentation to prototype.

As we pointed out in the *Discussion*, our results with regards to the measurement of the intuitiveness of the interactions between the playtesters and the game mechanics were inconclusive. We could not tell if the issue was in the design or the

implementation of the principle, which raises a question for future research: how can we better evaluate the player's perception of intuitive interaction in a cooperative setting?

This paper is only one example of how to report on the use of game design values and methods by game designers and developers. Further qualitative research on the practical application of different design values and methods would help game designers and developers to evaluate which ones would be a better fit to help them through their design & development processes (Dormans, 2009; Neil, 2012).

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9. Appendix

9.1. In-development usability reports

9.1.1. Playtesting Protocol for the in-development usability reports

When do we playtest?

- Week 10: 3rd of March to 9th of March

Where do we playtest?

- At ITU/DR
- In one of the smaller rooms, except for the 6th when we playtest with everyone else

What do we need to playtest?

- A build
- Snacks and water
- A computer
- Two controllers
- If we have two external playtester one team member is enough, while if we have only one external playtester we'll need two team members because one team member is playing
- One or two external playtester per playtesting session, we should test with a total of 5 external playtesters (Huguenin, 2018)
- Something to record the screen

Who are the external playtesters?

- Since it's a local co-op game: players who would seek out co-op games with someone they know (friends, family, partners, etc.)

What are the objectives of this set of playtests?

- Verify that our prototype works as intended
    - Verify that each feature works as intended
- Verify the usability and accessibility of our prototype
    - Report any bugs
    - Report any needed improvements with regard to usability and accessibility (this is where player feedback is key) → We will use them to iterate on our prototype's design.

What methods are we using for these playtests?

- Observation

How to run a playtest

1. Setup the prototype, water and snacks in one of the smaller meeting rooms at DR if possible (or go to the March 6th playtest).
2. Get either two external playtesters and one team member or one external playtester and two team members.
3. Have the playtesters (or the playtester and one team member) play while a team member takes observation notes on the features functionality. If possible also have a recording of the screen, so if bugs or issues are being recorded it is easier to reference them.

Description of the findings

- what did you find out
- analysis
- if you have suggestions for changing, adding, removing, or fixing something make them and explain why

9.2. In-development cooperative gameplay evaluation reports

9.2.1. Playtesting Protocol for the in-development cooperative gameplay evaluation reports

When do we playtest?

- March 25th 205
- March 27th 2025
- April 25th 2025
- May 1st 2025

Where do we playtest?

- At ITU/DR
- In one of the smaller rooms, except for the 6th when we playtest with everyone else

What do we need to playtest?

- A build
- Snacks and water
- A computer
- Two controllers
- Two external playtesters, while the recommended number is 20 total playtesters (Huguenin, 2018), we are unlikely to have that many so let's aim for as many as we can
- One team member
- Something to record the screen

Who are the external playtesters?

- Since it's a local co-op game: players who would seek out co-op games with someone they know (friends, family, partners, etc.)

What are the objectives of this set of playtests?

- Verify if our prototype is enabling cooperative gameplay
    - Use Aghabeigi (2006)'s cooperative performance metrics to verify how well our game enables cooperative gameplay → Identify areas of improvement and make suggestions to iterate on our prototype's design.

What methods are we using for these playtests?

- Observation
- Short qualitative interview

How to run a playtest

1. Setup the prototype, water and snacks in one of the smaller meeting rooms at DR if possible (or go to the March 6th playtest).
2. Get two external playtesters and one team member.
3. Note down the skill level of the playtesters on the spreadsheet.
4. Have the playtesters play while a team member takes observation notes the metrics listed on the spreadshee. If possible also have a recording of the screen, so if bugs or issues are being recorded it is easier to reference them.
5. After the playtest, ask both playtesters the questions listed below.

After the playtest, ask the following questions to the playtesters:

- Were there any specific moments where you remember working together to get past an obstacle?
- Were there any specific moments where you could have overcome an obstacle just as easily on your own?
- Were there any specific moments where it felt like playing with someone else was in the way of getting past an obstacle?
- Also ask any follow-up question you might have to what you observed
- Is there any particular part of the game that you liked?
- Is there any particular part of the game that you disliked?
- Do you have any feedback about how you think the game could be improved to be more fun to play together with another player (for you)?

Description of the findings

- what did you find out
- analysis
- if you have suggestions for changing, adding, removing, or fixing something make them and explain why

9.2.2. 25/03/2025 - Playtest Session A (one pair of playtesters)

	Player A1	**Player A2**
Frequency of playing cooperative games	Less frequently than once per year	At least once per year
Frequency of playing 3D platformers	Less frequently than once per year	At least once per week
Frequency of playing puzzle games	-	-
How do they know each other	They are friends	
Enjoying the game together (positive)	No	No
Worked out strategies (positive)	Yes	Yes
Global strategies (positive)	Yes	Yes
Helping each other out (positive or negative depending on why and how it happens)	Yes	Yes
Waited for each other (negative)	Mixed	Mixed
Got in each other's way (negative)	No	No

Experience level: both playtesters play cooperative games and 3D platformers less frequently than once per year

- Enjoyment while playing in cooperative mode: the playtesters did not express verbally or with non-verbal behaviors that they enjoyed the game while they were playing, and they laughed together only in response to a bug. So **there is improvement to be made with regards to making the gameplay enjoyable**.
- Worked out strategies: the playtesters talked about how to solve the shared challenges, consulted each other while navigating the would and pre-planned what to do. This means that **our gameplay does afford for cooperative play with regards to planning and working together**.
- Helping each other: one playtester had to explain the controls to the other and discussed how to overcome a shared obstacle. We need to have a clearer image for the control schemes.
- Player roles: Player A1 and Player A2 felt that pulling felt better than pushing, as it has more control over the object. In some challenges one of the players was

waiting for the other to complete the challenge alone. → **We should think of a way that would give a greater sense of control over the pushing.**
- Player A2 did not look at the line to know what is being targeted, she looked at the targeted object which means that **we need to color code them as well as having the line connecting it**.

Other stuff

- When the targeted object is out of frame it looks like the player is tied to it. → **stop targeting an object that is out of frame**.
- **Laura needs to fix the walls in the levels before playtesting on thu**
- **We need to polish the camera and wall collisions**
- **We cannot have diagonal sliding doors**
- A pointer to point stuff at the other player would be nice, but super low priority (even to do after the thesis hand-in)

9.2.3. 27/03/2025 - Playtest Session B (three pairs of playtesters)

	Player B1	**Player B2**	**Player B3**	**Player B4**	**Player B5**	**Player B6**
Frequency of playing cooperative games	Weekly	Yearly	Less than yearly	Yearly	Weekly	Weekly
Frequency of playing 3D platformers	Yearly	Monthly	Less than yearly	Never	Yearly	Yearly
Frequency of playing puzzle games	Monthly	Monthly	Weekly	Yearly	Weekly	Monthly
How do they know each other	They are in the same Master's course		They are partners		They are in the same Master's course	
Enjoying the game together (positive)	Yes	Yes	Yes	Yes	Yes	Yes
Worked out strategies (positive)	Yes	Yes	Yes	Yes	Yes	Yes
Global strategies (positive)	Yes	Yes	Yes	Yes	No	No

	Player B1	**Player B2**	**Player B3**	**Player B4**	**Player B5**	**Player B6**
Helping each other out (positive or negative depending on why and how it happens)	No	No	No	No	No	No
Waited for each other (negative)	No	No	Not for the CPM, but the Pusher felt useless in some puzzles	Not for the CPM, but the Pusher felt useless in some puzzles	No	No
Got in each other's way (negative)	No	No	No	No	No	No

Does the game perform well with regards to enabling cooperative play? Yes.

- The experience of the three pairs of playtesters were similar, regardless of the frequency by which they play similar game or of difference in frequency
- All three pairs of playtesters expressed that they enjoyed playing the game together while they were playing. → The game succeeds in being enjoyable by playing together.
- All three pairs of playtesters communicated with each other about how to coordinate/work together to overcome obstacles. → The game succeeds in giving a reason for cooperative play.
- There isn't much need for playtesters to help each other in our game, since there isn't a lot of danger etc.
- With regards to the metrics in CPM they were not waiting for each other, however, it has been noted by two pairs that push sometimes feels less useful than pull.
- They do not get into each other way

Level design improvement notes:

- The game is longer than it should be: playtesters generally take 20-25min to go through the game with the help of the hand of god.
    - Considering where to cut here are my (Laura)'s suggestions:
        - Make the first puzzle shorter

        - Condense even more the “creating a platforming path with the moving platforms” area, have only one pillar there and give players elevator platforms to get up instead (horizontal platforms and vertical platforms will have to be visually distinct)
        - Remove the level where players split up, the sliding door does not help to keep them separated anyway and they don’t really use the elevator platform
    - → This should reduce playtime while also leaving space for the AOE puzzle

- At least two pairs of playtesters carried movable objects with them from one puzzle to the other. I have no issue with that let them have their fun

- Of the puzzles tested (all except the aoe one) the one on rails and the maze were the ones where the playtesters were actually actively playing together. (Note to self: design more puzzles on paper while sleep-deprived and coughing)

- In some puzzles the Pusher felt useless. Combined with the fact that push is also less controllable than pull we should try to improve the experience of the Push player.

- To Player B5 and Player B6. some puzzles were very clear and linear, while others felt more like a fuck around and find out experience (both cases were fun)

- Players really enjoyed launching themselves with the objects xD (I don’t mind, I’ve just put a ceiling on so that they don’t yeet themselves or objects out of the map

Quality of life stuff:

- Players who tend to not stay close to each other would like to be able to tell to cinemachine which player to prioritize (since after a some distance cinemachine always chooses one player over the other)
- We can remove the HUD showing the abilities strength level now, we don’t need it anymore so now it’s just noise
- The fact that the targeting line stays even when the player is no longer thinking about targeting an object was confusing. → Suggestion, we can give a control to un-target it: if we put the targeting on the dpad we can do left-right target, down untarget

Games that they were reminded of while playing:

- Portal
- The maze puzzle reminded them of a puzzle in Zelda Breath of the Wild

9.2.4. 25/04/2025 - Playtest Session C (two pairs of playtesters)

	Player C1	**Player C2**	**Player C3**	**Player C4**
Frequency of playing cooperative games	Monthly	Weekly	Yearly	Monthly
Frequency of playing 3D platformers	Less than once per year	Less than once per year	Yearly	Monthly
Frequency of playing puzzle games	Less than once per year	Daily	Daily	Yearly
How do they know each other	They are partners		They work on a project together	
Enjoying the game together (positive)	Yes	Yes	Not visibly while playing	Not visibly while playing
Worked out strategies (positive)	Yes	Yes	Yes	Yes
Global strategies (positive)	Yes	Yes	Yes	Yes
Helping each other out (positive or negative depending on why and how it happens)	No	No	No	No
Waited for each other (negative)	Yes	Yes	No	No
Got in each other's way (negative)	No	No	No	No

Good things:

- The players enjoyed the game when they had to coordinate what they did
- The nice and goofy vibe was enjoyable

Gameplay known issues:

- It still felt like pull was carrying the game, even if less so than before. Puzzles that felt more balanced where moving the platforms, the doors and the aoe. → I don't know if we can do much more about this with were we are at now. We might have to consider it one co-op fail for the hand-in and explain how we tried to mitigate, what we learned from it and what we could do in the future to solve it.

Level Design issues that are easily solvable:

- Task for Hanna: when you add panels for shadows and other stuff that the player should be able to walk through, remember to de-activate its collider. Otherwise the player will be unable to move through some doors or it is not possible to place a movable object on the button (example: LevelDesign_P1). → Solution: deactivate colliders that prevent players from progressing the game, and all colliders that don't need to be there
- Task for Mikkel: there are many places in level where the camera makes the game unplayable because it gets too close to one or both players. → Solution part 1: have a more top-down angle of the camera (this might require telling the camera to not collide with the ceilings). Solution part 2: have two team members play together and adjust the level to avoid camera weirdness (to Mikkel: ask who is available of Hallur, Hanna or Laura and meetup when agreed to work on this one morning or one afternoon).
- Task for Mikkel: if there are any stairs with a ramp collider then turn all stairs into ramps or give them their mesh colliders, the players were very confused and ended up falling inside the stairs.
- Task for Mikkel: adjust the mass and dampening of the movable objects in LevelDesign_P5 so that they feel controllable with medium strength (for precision stuff min strength) and don't get flinged around. Schedule a testing with another team member to either do it together or to check that what you've changed works nicely.
- Task for Mikkel: none of the playtesters understood the LevelDesign_P2 button puzzle, but they did understand the LevelDesign_P3 and LevelDesign_P6 button puzzles (because the interaction with boxes is something that made sense for them to do with their abilities). → Solution: So LevelDesign_P2 button puzzle is not necessary to understand the others and should be yeeted since it causes confusion and does not make them use their abilities, while the other aoe puzzles are good.
- Task for Mikkel: The blinking needs to be either way softer or absent, since it caused discomfort.
- Task for Mikkel: your observations about the maze being not good if you can access it from all sides was correct. Solution: block off the right and up sides (adjusting the level by consequence.

- Task for Mikkel: we need to completely prevent players from jumping on the puzzle and from going under it, as it creates huge problems with the camera. Solution: add glass walls that prevent the players from getting on the puzzle.

9.2.5. 01/05/2025 - Playtest Session D (one pair of playtesters)

	Player D1	Player D2
Frequency of playing cooperative games	At least once per year	At least once per month
Frequency of playing 3D platformers	At least once per week	At least once per month
Frequency of playing puzzle games	At least once per week	At least once per week
How do they know each other	They are in the same Master's course	
Enjoying the game together (positive)	Yes	Yes
Worked out strategies (positive)	Yes	Yes
Global strategies (positive)	Yes	Yes
Helping each other out (positive or negative depending on why and how it happens)	No	No
Waited for each other (negative)	Yes	Yes
Got in each other's way (negative)	A little bit but they both seemed amused when it happened. It wasn't an annoyance as much as it was just "fun coop behavior"	A little bit but they both seemed amused when it happened. It wasn't an annoyance as much as it was just "fun coop behavior"

Good things:

- There were NO camera issues
- There were no overt frustrations over the puzzles
- There were a lot of laughs
- The players seemed to enjoy taking a step back and figuring out what to do
- They explored the levels to look for clues when they were unsure of what to do next
- They really enjoyed the AOE challenges especially as they required more of a plan, setup, execute approach (setting up the boxes and pushing the simultaneously)

- Neither playtester brought up the Puller as carrying the game, even when I mentioned it in another context

Issues:

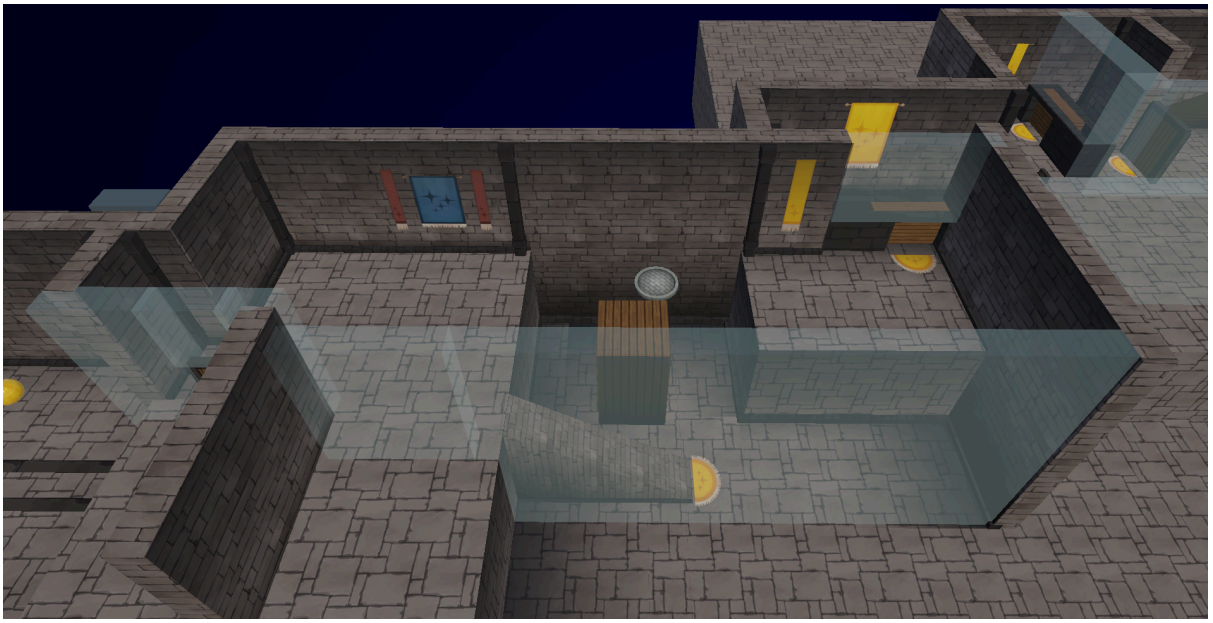
- There wer some technical issues where the sliding doors did not work. This has been fixed now, but definitely affected the flow of the experience.
- Julian kept using the AOE instead of targeted until later in the test, it seemed like he didn't notice it half the time.
    - Both players would like to see more distinct AOE VFX and/or sound SFX.
- Stairs kept getting in the way. These need to be fixed or turned into ramps instead.

Things they would like to see in a future build:

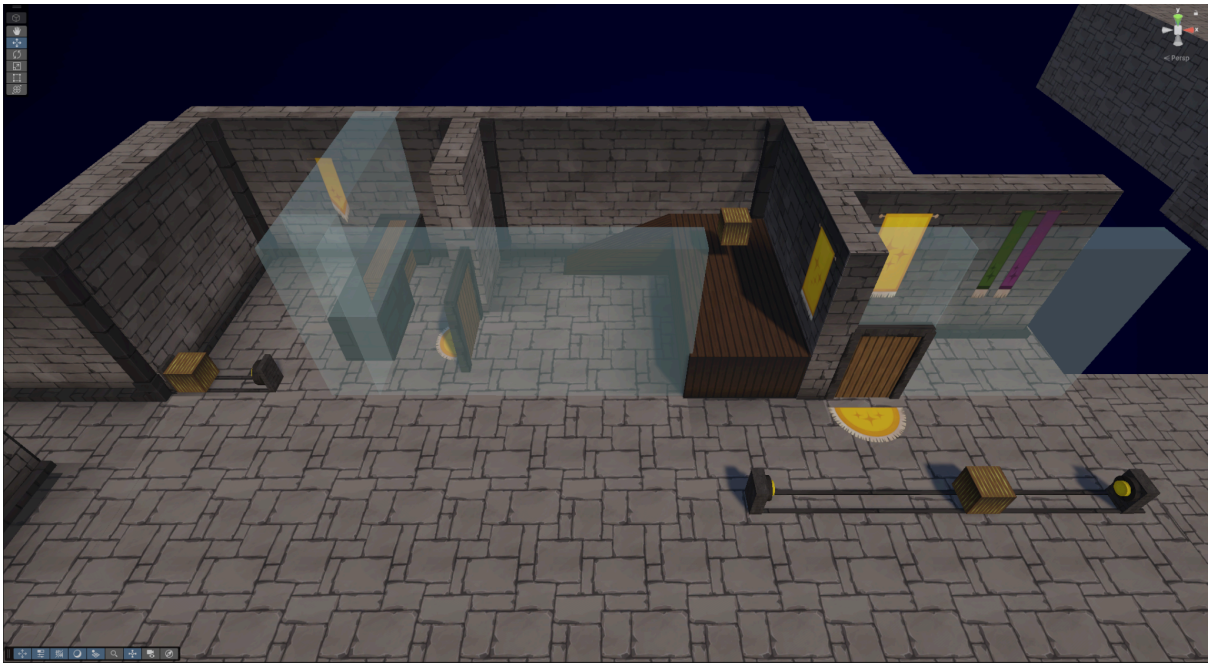
- Color-coded target lasers to make the targeting less confusing.
- More VFX/SFX, especially on the AOE to make it feel more distinguishable.
- Make the minimum-distance target color something more intuitive, as Julian didn't notice until later that the green laser meant it was off.

9.3. Demo Sections Screenshots

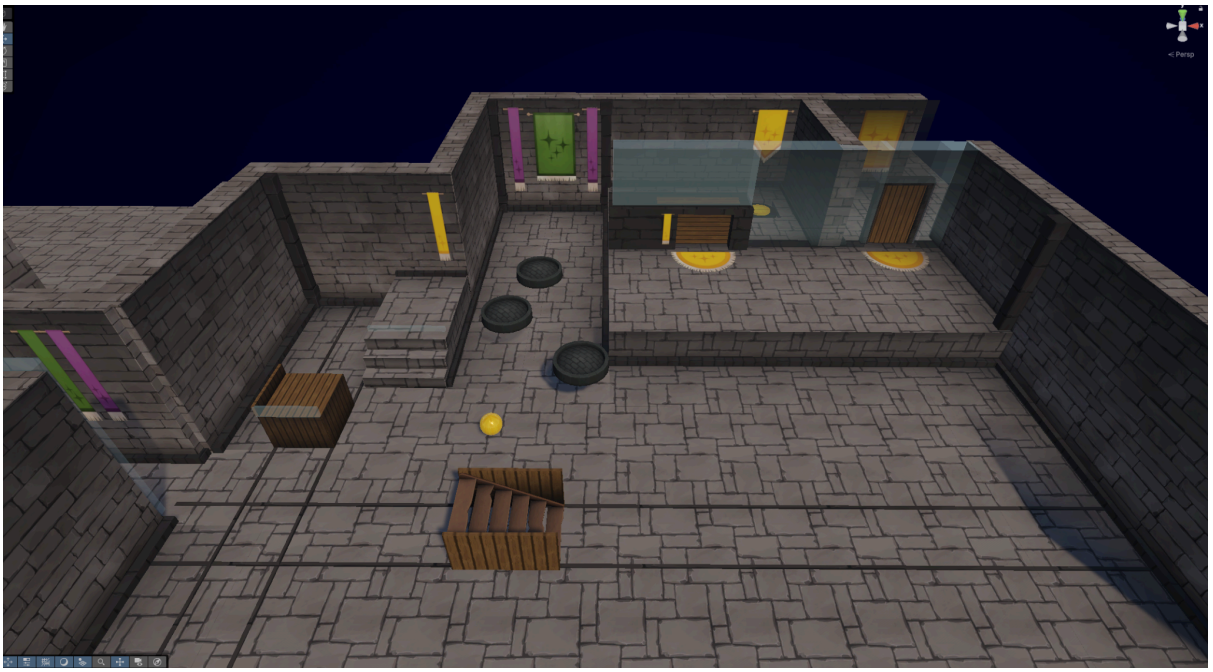
Section 1 of the demo



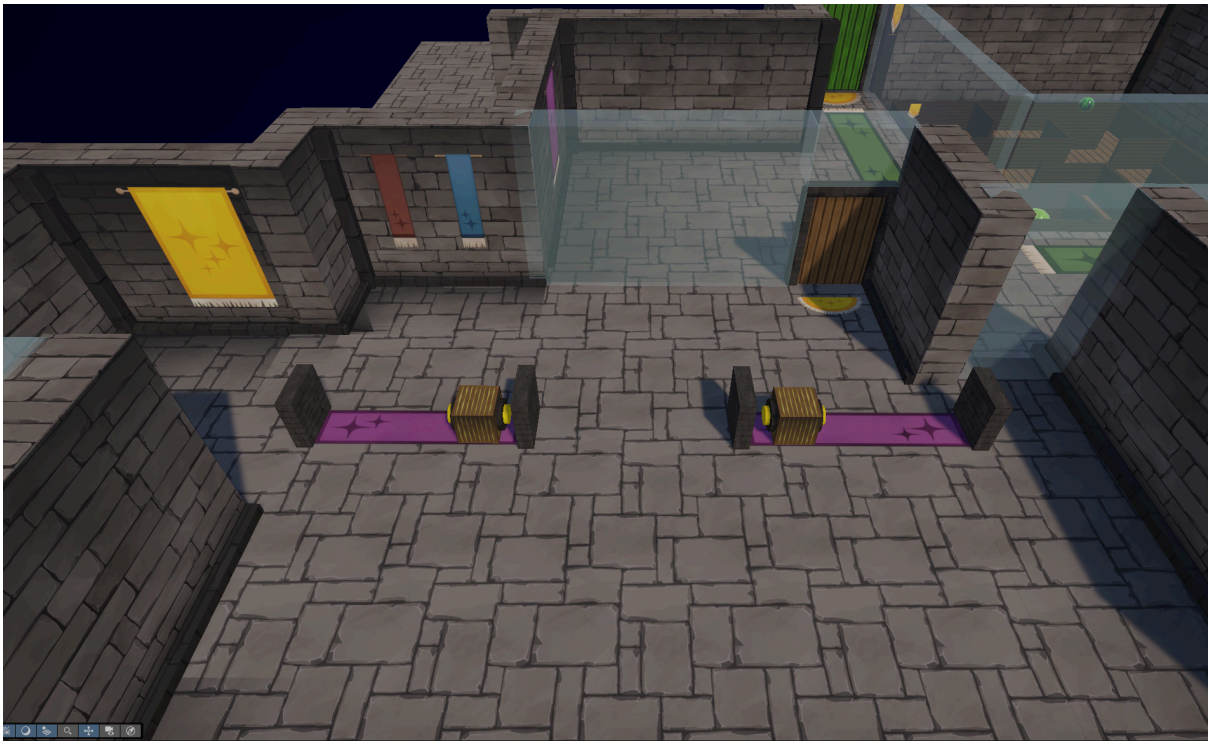
Section 2 of the demo



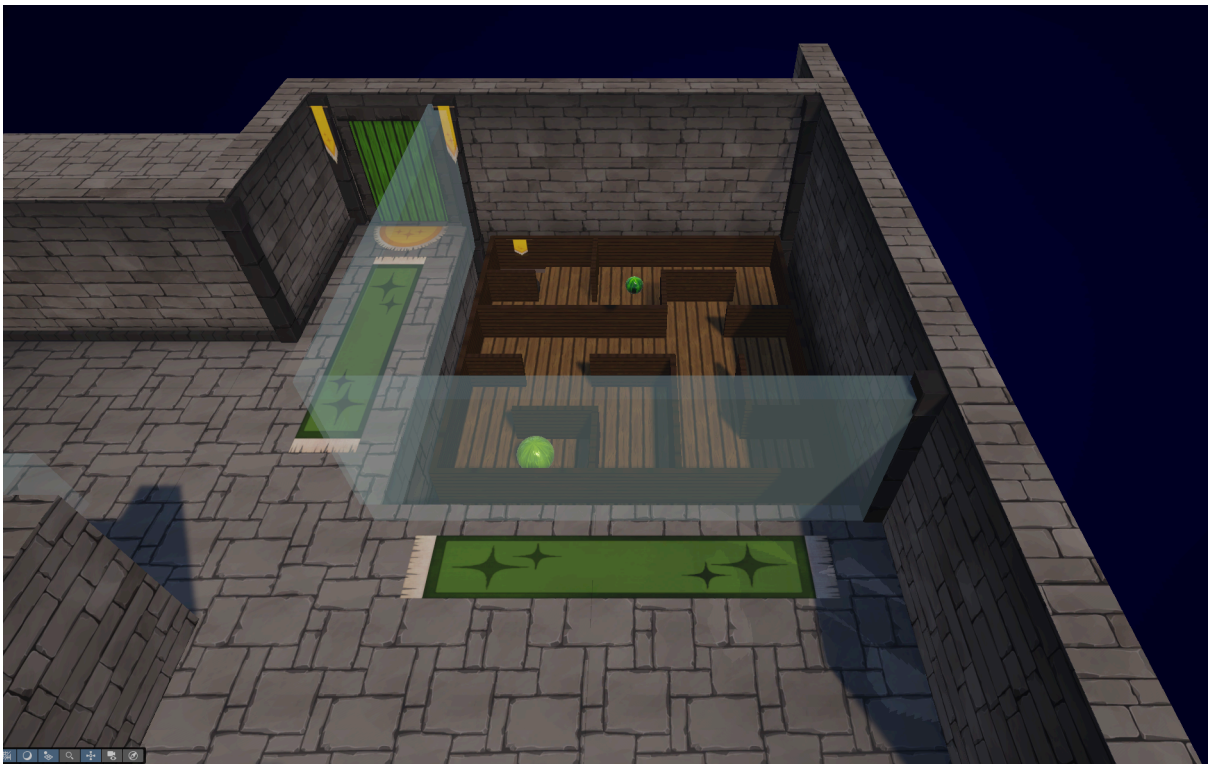
Section 3 of the demo



Section 4 of the demo



Section 5 of the demo



Section 6 of the demo

9.4. Demo Playtests Reports

Note for the reader: we asked all the questions listed in the playtesting protocol in *Chapter 4* to all playtesters, but here we transcribed only the answers to the questions that prompted insights.

9.4.1. Playtest 1

	Push_1	**Pull_1**
Frequency of playing cooperative games	Less frequently than once per year	At least once per day
Frequency of playing 3D platformers	Less frequently than once per year	At least once per day
Frequency of playing puzzle games	Less frequently than once per year	At least once per day
How do they know each other	Work on project together	
Enjoying the game together (positive)	Mostly no, only in section 6 (maze)	Yes
Worked out strategies (positive)	Yes	Yes
Global strategies (positive)	No	No
Helping each other out (positive or negative depending on why and how it happens)	No	Yes
Waited for each other (negative)	No	Yes
Got in each other's way (negative)	No	Yes

Highlighted answers to the interview questions:

- Is there any particular part of the game that you disliked?
    - This question prompted Push_1 to say that she had found the controls to be a bit confusing, but that having the other player with her helped. Pull_1 also pointed out to have found the controls confusing, he specifically did not understand the intensity settings of the ability.
- Were there any specific moments where the game presented you with an obstacle that you could have overcome just as easily on your own?
    - This question prompted the players to talk about the fact that Pull felt more reliable as an interaction than Push, and they stated that this is why the used it more.

Noteworthy Details:

- Push_1 rarely plays videogames.
- Both players were not very communicative. They agreed that had they not been told to speak English they would have spoken more. This was rectified in the next tests, allowing all playtesters to speak either Danish or English.

Positives:

- Toward the end of the prototype the players seemed to get more the hang of both the controls and the game logic, enabling more coordination and strategy.
- They also ended up taking different roles, though without much discussion.

Negatives:

- Controls were confusing for both. A lot of information in the beginning without much onboarding/tutorial to introduce the mechanics.
- Did not really use AOE ability.
- Pull_1 did most of the explanation of the puzzles and the coordination, essentially guiding the Pusher most of the time.
- Both did not really utilize the different intensities but mostly relied on the strongest intensity.

9.4.2. Playtest 2

	Push_2	**Pull_2**
Frequency of playing cooperative games	At least once per month	At least once per week
Frequency of playing 3D platformers	At least once per year	Less frequently than once per year
Frequency of playing puzzle games	At least once per year	At least once per year
How do they know each other	They just met	
Enjoying the game together (positive)	Yes	Yes
Worked out strategies (positive)	Yes	Yes
Global strategies (positive)	Yes	Yes
Helping each other out (positive or negative depending on why and how it happens)	No	Yes
Waited for each other (negative)	No	No
Got in each other's way (negative)	No	No

Highlighted answers to the interview questions:

- Were there any specific moments where you remember working together to get past an obstacle?
    - This question prompted both Push_2 and Pull_2 to say that they felt like they could not have completed the game without the other player and their ability.
- Do you have any feedback about how you think the game could be improved to be more fun to play together with another player (for you)?
    - This question prompted a player to say that it took him a while to realize that the two of them had different powers, but that once that the other player told him it made sense.
- "Do you have any feedback about how you think the game could be improved to be more fun to play together with another player (for you)?"
    - The players commented that they used less controls than the ones they had available (did not use aoe as often as the level design intended, and did not change the ability strength much).

Noteworthy Details:

- Playtesters never met before, but were very engaged and communicative throughout the demo.

Positives:

- The demo seemed to facilitate a lot of collaboration between two people who had not met each other before.
- They were very talkative throughout, engaging with each other in the context of the puzzles and their individual mechanics.
- Both players verbally expressed satisfaction at the completion of puzzles and good coordination.
- Players made references to previous puzzles and their solutions when encountering new ones.
- Both players expressed that powers felt complementary to each other, and that they couldn't have completed the puzzles without the other.

Negatives:

- Push_2 did not realize they had different powers in the beginning until Pull_2 reminded him.
- Both players expressed that they felt that they weren't using all the buttons because it wasn't necessary most of the time

9.4.3. Playtest 3

	Push_3	**Pull_3**
Frequency of playing cooperative games	Never played these genres of games	At least once per year
Frequency of playing 3D platformers	Less frequently than once per year	Never played these genres of games
Frequency of playing puzzle games	Never played these genres of games	Never played these genres of games
How do they know each other	They're in the same study group	
Enjoying the game together (positive)	Yes	Yes
Worked out strategies (positive)	Yes	Yes
Global strategies (positive)	No	No
Helping each other out (positive or negative depending on why and how it happens)	Yes	Yes
Waited for each other (negative)	No	No
Got in each other's way (negative)	Yes but intentionally for fun	Yes but intentionally for fun

Highlighted answers to the interview questions:

- Were there any specific moments where you remember working together to get past an obstacle?
    - To this question, one of the playtesters noted that they found that the Push/pull relationship had a lot of potential.
- Is there any particular part of the game that you disliked?
    - This question prompted one of the playtesters to note that he found the mechanics to be kind of difficult. The same playtester noted that they often ended up using the AOE mode for most interactions (even those intended for Single Target mode).
    - One of the playtesters also noted that the jump wasn't smooth enough and it was difficult to time it correctly.

Positives:

- A lot of talking in context of mechanics and the puzzles
- A lot of fooling around and intentionally getting in each other's way. While this might not progress the demo, we still see it as a positive as the demo was facilitating laughter and visceral enjoyment from the players and they were actively engaging with the mechanics and using them intentionally.
- Players felt the Push/pull mechanics had potential

Negatives:

- Pull_3 did not like the jump and felt it was difficult to time correctly
- Push_3 felt that AOE was more useful in general than single target
- Because they were using AOE a lot they didn't notice the minimum distance until later because the AOE does not give any feedback on this

9.4.4. Playtest 4

	Push_4	**Pull_4**
Frequency of playing cooperative games	At least once per week	At least once per week
Frequency of playing 3D platformers	At least once per year	At least once per year
Frequency of playing puzzle games	At least once per year	At least once per year
How do they know each other	They're in the same study group	
Enjoying the game together (positive)	Yes	Yes
Worked out strategies (positive)	Yes	Yes
Global strategies (positive)	Yes	Yes
Helping each other out (positive or negative depending on why and how it happens)	Yes	Yes
Waited for each other (negative)	No	No
Got in each other's way (negative)	No	No

Highlighted answers to the interview questions:

- Is there any particular part of the game that you liked?
    - The playtesters said that they liked the sounds.
    - The playtesters said that they liked the way they had to work together and that they complimented each others abilities.
    - The playtesters liked being able to switch between Single Target Mode and AOE mode.
    - The playtesters liked being able to plan and execute a plan, for example when they made a bridge for the ball in section 4.
- Is there any particular part of the game that you disliked?
    - This question prompted the playtesters to say that it was difficult to see what to do with the maze. They saw that they could tilt it, but did not understand that that was connected to the ball above the maze, which is why they kept using AOE during that challenge. It was also frustrating

not being able to see how much the maze was tilted with how the camera is set up in the demo.

- Do you have any feedback about how you think the game could be improved to be more fun to play together with another player (for you)?
    - The playtesters said that they would have liked to be able to zoom out more.

Positives:

- Both players used both target and AOE interchangeably after getting used to the controls and mechanics.
- Players express satisfaction at completion of challenges
- One of the more smooth tests, players quickly figured out the mechanics and controls and managed to get by the challenges quite smoothly
- They generally liked the way the mechanics and levels were designed to encourage teamwork. They liked working together and complementing each other's abilities.

Negatives:

- They used AOE to move the maze. They did not realize the red ball was the target which caused frustration.
- Sometimes they found it difficult to see the whole challenge and wanted a zoom-out function.

9.4.5. Playtest 5

	Push_5	**Pull_5**
Frequency of playing cooperative games	At least once per week	Less frequently than once per week
Frequency of playing 3D platformers	At least once per month	At least once per month
Frequency of playing puzzle games	At least once per week	At least once per day
How do they know each other	They’re classmates	
Enjoying the game together (positive)	Yes	Yes
Worked out strategies (positive)	Yes	Yes
Global strategies (positive)	Yes	Yes
Helping each other out (positive or negative depending on why and how it happens)	Yes	Yes
Waited for each other (negative)	No	No

	Push_5	**Pull_5**
Got in each other's way (negative)	No	No

Highlighted answers to the interview questions:

- Were there any specific moments where the game presented you with an obstacle that you could have overcome just as easily on your own?
    - They pointed out that the puzzles with the sliding cubes could be done with just either pull or push.
- Is there any particular part of the game that you liked?
    - The playtesters said that they really liked the Push and Pull abilities, they felt complementary.
    - They also liked the game feel of the characters, between movement and using the abilities.
    - They said to have liked the sections where they had to cooperate with the platforms.
    - They enjoyed the chaos that the AOE mode allowed to enact.
    - They had fun when talking together about strategies.
- Do you have any feedback about how you think the game could be improved to be more fun to play together with another player (for you)?
    - They playtesters said that they felt unsure about when it was more useful to use an intensity level rather than others, they only used the maximum one.

Positives:

- Both players said "that was very fun" at the end, unprompted.
- A lot of coordination between players and when/how to use each ability.

Negatives:

- Both players kept using AOE even though it was causing issues. They later figured this out, however it hints at another case of a tutorial being needed.
- Sometimes they solved puzzles by accident just by doing random things.

9.4.6. Playtest 6

	Push_6	**Pull_6**
Frequency of playing cooperative games	At least once per year	At least once per week
Frequency of playing 3D platformers	At least once per week	At least once per month
Frequency of playing puzzle games	At least once per week	At least once per month
How do they know each other	They are working on a project together	

	Push_6	**Pull_6**
Enjoying the game together (positive)	Yes	Yes
Worked out strategies (positive)	Yes	Yes
Global strategies (positive)	Yes	Yes
Helping each other out (positive or negative depending on why and how it happens)	Yes	Yes
Waited for each other (negative)	No	No
Got in each other's way (negative)	No	No

Highlighted answers to the interview questions:

- Were there any specific moments where the game presented you with an obstacle that you could have overcome just as easily on your own?
    - They said that they felt like they needed to work together in all the puzzles and that all parts of the game needed cooperation.
- Is there any particular part of the game that you liked?
    - This question prompted the playtesters to say that the game reminded them of *Fire Boy and Water Girl*.
    - They said that they liked the puzzles.
- Is there any particular part of the game that you disliked?
    - They said that they found it annoying when a player ended up out of the camera's frame[29].
    - They said that they were confused on whether or not they could push/pull objects with wooden textures.
    - They also felt that the AOE mode was unintuitive, because it does not give them feedback when an object is too close to be affected by it.
- Do you have any feedback about how you think the game could be improved to be more fun to play together with another player (for you)?
    - This question also prompted them to point out that they noticed that it was not possible to push/pull the movable platforms if a player is standing on them, and said that they assumed this was because it would be too easy otherwise[30].
    - They also noted that the characters reminded them of garden gnomes.

Noteworthy Details:

- Both players noted that they are inexperienced with controllers.
- These players received a lot of hints throughout the game as they were hitting a lot of roadblocks.

[29] *which is fair*
[30] they are indeed correct

Positives:

- Unprompted saying “this is fun” and similar phrases, repeated laughs and expressions of satisfaction at completing challenges.
- A lot of communication back and forth. Even stopping occasionally to scope out the room and ask “how do we do this?”
- Despite receiving a lot of help they still seemed to grasp the mechanics and used them to cooperate.
- They felt that they needed to work together for all the different puzzles.

Negatives:

- Players quickly forgot that they are not both able to push and pull, so this had to be mentioned again.
- Expressed confusion about who could do what, and wanted a more in-depth tutorial to explain this.
- They did not understand the first sliding door due to the wood texture, they thought it was a static object.
- “I’ll get the camera for you”, expressed mild frustration at the limited camera and not being able to be farther apart without the camera limiting the view.

9.4.7. Playtest 7

	Push_7	**Pull_7**
Frequency of playing cooperative games	Less frequently than once per year	At least once per year
Frequency of playing 3D platformers	Less frequently than once per year	At least once per week
Frequency of playing puzzle games	Less frequently than once per year	At least once per week
How do they know each other	They are classmates	
Enjoying the game together (positive)	Yes	Yes
Worked out strategies (positive)	Yes	Yes
Global strategies (positive)	Yes	Yes
Helping each other out (positive or negative depending on why and how it happens)	Yes	Yes
Waited for each other (negative)	Yes	Yes
Got in each other’s way (negative)	No	No

Highlighted answers to the interview questions:

- Were there any specific moments where the game presented you with an obstacle that you could have overcome just as easily on your own?
    - The paytesters said that they felt like they had to cooperate throughout the whole game and that the other person was needed for all the puzzles, even if they both attempted to do things on their own.
- Is there any particular part of the game that you liked?
    - Their favorite part was the maze, as it was neither too easy nor too difficult and felt like it gave good feedback on their actions.
    - They said that they had lots of fun and that they really liked the player characters' visual design, it reminded them of little wizard gnomes carpenters.
    - Pull_7 pointed out that the game put her "in the loop", she did not need to think a lot and it was intuitive to know what to do.
- Is there any particular part of the game that you disliked?
    - Push_7 noted that he found the more open areas to be frustrating in combination with the camera which would prioritize one player over the other.
- Do you have any feedback about how you think the game could be improved to be more fun to play together with another player (for you)?
    - They noted that section 2 felt really difficult, because they were still learning how to play.

Noteworthy details:

- They have used the AOE mode to move the platform in section two, which while is not the intended solution, is still a creative alternative approach. I don't count it as positive because it is not an approach that brings both players on the other side.
- When entering a new area they usually first wandered around independently to check things out and eventually rejoined to solve the challenge.

Positives:

- They quickly understood Sections 4-6.
- They solved Section 4 in an unprecedented way but that still fit the spirit of the assignment and was cooperative. They used the ramp to move the ball onto the bigger box, then instead of moving the bigger box they lined up the platform to create a launching ramp to get the ball from the bigger box to floor 2. They successfully got the ball on the other side this way by coordinating their actions.
- They said that they felt like they had to cooperate throughout the game and that the other person felt needed in every challenge, despite trying to do things on their own.
- They especially liked the maze because they felt that it was neither easy nor too difficult, and they felt that it had good feedback.
- Pull_7 noted that she was in the loop and that it was intuitive what to do.

Negatives:

- The change of color of the Single Target mode line was not understood.
- Section 2 was really difficult because they still did not understand how to play.
- They were frustrated in the more open areas like section 3 and section 4. because of the camera

9.4.8. Differences in frequency of play

Frequency of playing cooperative games		
Push_1	Pull_1	Level of difference
Less than yearly	Daily	Very different
Push_2	Pull_2	Level of difference
Monthly	Weekly	Very similar
Push_3	Pull_3	Level of difference
Never	Yearly	Slightly similar
Push_4	Pull_4	Level of difference
Weekly	Weekly	Same
Push_5	Pull_5	Level of difference
Weekly	Monthly	Very similar
Push_6	Pull_6	Level of difference
Yearly	Weekly	Slightly similar
Push_7	Pull_7	Level of difference
Less than yearly	Yearly	Very similar

Frequency of playing cooperative games		
Push_1	Pull_1	Level of difference
Less than yearly	Daily	Completely differently
Push_2	Pull_2	Level of difference
Yearly	Less than yearly	Very similar
Push_3	Pull_3	Level of difference
Less than yearly	Never	Very similar
Push_4	Pull_4	Level of difference
Yearly	Yearly	Same
Push_5	Pull_5	Level of difference
Montly	Monthly	Same
Push_6	Pull_6	Level of difference
Weekly	Monthly	Very similar
Push_7	Pull_7	Level of difference
Less than yearly	Weekly	Slightly different

Frequency of playing cooperative games		
Push_1	Pull_1	Level of difference
Less than yearly	Daily	Completely differently
Push_2	Pull_2	Level of difference
Yearly	Yearly	Same
Push_3	Pull_3	Level of difference
Never	Never	Same
Push_4	Pull_4	Level of difference
Yearly	Yearly	Same
Push_5	Pull_5	Level of difference
Weekly	Daily	Very similar
Push_6	Pull_6	Level of difference
Weekly	Monthly	Slightly similar
Push_7	Pull_7	Level of difference
Less than yearly	Weekly	Slightly different