Designing Multi-Mode Player Abilities to Enhance Backtracking in Metroidvania Levels

Master’s thesis in Computer science and engineering

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Abstract

Metroidvania games generally possess connected worlds where new powers affect the way players move through previous areas. This helps players make logical progress, enabling them to unlock new regions of the game world. But if the same obstacles are repeatedly dealt with through the same methods, players may feel less like they are discovering and more like they are going down the same path again. This project explores the possibility of a multi-form ability system that supports varied backtracking while keeping progression readable. The prototype is a small-scale 2D Metroidvania game built around a single core ability with varying forms. The distinctive features of each form affect how players engage with obstacles, routes and revisited spaces, which allows them to find different ways to deal with comparable situations. The prototype was developed through "research through design". Its level design links main paths, optional paths, visible rewards and revisitable areas to create new meaning for earlier spaces after obtaining new forms. Based on playtesting and questionnaire feedback, the system is perceived as more of a reinterpretation of space rather than simply traveling through it again. Players responded positively to exploration, route variation, and the variety of ways the ability system can be used. But the results also show that control feel, guidance, feedback and form communication should be further improved. This project demonstrates that multi-form ability design can support meaningful backtracking in a Metroidvania-style prototype when form functions are clear, environmental cues are consistent, and the main route remains comprehensible alongside optional revisits.

Keywords: Metroidvania, backtracking, multi-form ability system, ability gating, level design.

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Contents

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Introduction

Metroidvania games are often characterized by huge, interlocked environments where exploration is facilitated by new abilities. These abilities increasingly open up more places on the map and the challenges they offer [1]. This design tends to form a pattern of revisiting previous locations, since progress is controlled by gates and barriers that cannot be crossed until a certain change in the state of the game [2]. On the one hand, this makes progression easy to understand. On the other hand, when similar obstacles are matched to one expected solution, it makes the play pattern more predictable, and revisits feel more like repeating a known route than exploring new possibilities.

Another important element of the challenge in this genre is navigation. Players need to decide where to go and how to get there in a connected world where exploration is non-linear but shaped by their current abilities [3]. This creates a vital requirement: the progression should be legible while still making players feel that returning to spaces may offer new planning opportunities and results.

The playable prototype developed for this project is called *Underisle*. It begins on the surface of a floating island above a sea of clouds and leads the player downward into the island's interior, toward a forgotten sanctuary. The game is based on exploration and rediscovery. As players acquire new forms of Aether, previously visited areas can reveal new entrances, shortcuts, and connecting routes. The main gameplay is built around liquid, solid, and gaseous Aether forms, which allow players to move through the level, interact with the environment, solve spatial problems, and reinterpret areas they have already visited.

1.1 Research Question

The research question that this project seeks to answer is

> *"In what ways can the design of a multi form ability system in a Metroidvania prototype broaden solutions to interlocked environments while maintaining legible progression and reducing repetitive backtracking?"*

1.2 Stakeholders

This project mainly serves game designers and developers who are interested in practical examples of how flexible ability systems can grow the solution space without becoming disorganized. It may also be relevant to players who enjoy exploration, route planning, and puzzles in Metroidvania-style games, since the prototype examines player-facing experiences of route choice and backtracking. Simultaneously, players who prefer very direct orientation or linear progression might be less attracted to increased choice when it generates uncertainty, even when the desired progression can still be recognized.

1.3 Aim

The objective of this project was to design and produce a small-scale Metroidvania prototype centred on a material-based ability called Aether, which shifts between liquid, solid, and gaseous forms. The project also examined whether this design could expand the number of valid solutions to obstacles without making the overall structure harder to follow. The work included developing a playable prototype in which a single ability has multiple, distinct forms, and obstacles that can be resolved in various ways through those forms. It also included setting the game levels so that players can revisit earlier sections and discover new possibilities, rather than merely repeating previous actions, as outlined in the problem description.

1.4 Project Outcomes

The project has two main outcomes. The first is a small-scale playable 2D Metroidvania prototype centred on a multi-form material ability called Aether. The player controls a character who can generate and use Liquid, Solid, and Gas Aether. Each form supports a distinct type of environmental interaction: Liquid Aether affects lightweight objects and liquid-sensitive mechanisms, Solid Aether breaks designated barriers, and Gas Aether activates vertical devices that provide access to elevated routes.

The prototype functions as a research artefact for exploring whether several related forms of one ability can broaden the available environmental interactions and revisit opportunities while maintaining readable progression. It does not attempt to reproduce the scale or complexity of a complete commercial Metroidvania game. Instead, it provides a limited and testable environment in which the relationship between ability design, route structure, and backtracking can be examined through iterative development and playtesting.

The second outcome is documentation of the design and implementation process. This includes the thesis itself and the Game Design Document provided in Appendix B. The documentation records the design rationale, Aether-form interaction rules, level and obstacle structure, revisit routes, implementation decisions, and changes made during development. Together, the playable prototype and supporting documentation provide the basis for addressing the research question.

1.5 Ethical and Social Considerations

This project primarily serves game designers and developers; therefore, the ethical focus was on how the work was tested and how player feedback was handled. In game research and development, player data is frequently used to support design decisions. This is why it was important to be transparent about the information that was gathered, why it was required, and how it was stored and used. In practice, the playtesting followed a simple consent and data handling protocol. Before taking part, participants were informed that the test was conducted for a master's thesis project and that their responses would be used only for academic analysis of the prototype. Participation was voluntary, and participants could choose whether to complete the questionnaire after playing. The questionnaire did not ask for names, contact details, or other directly identifying information. Responses were collected in an anonymised form and were only used to identify patterns related to progression clarity, Aether form understanding, backtracking, control feel, and feedback. When participant comments are discussed in the thesis, they are presented without personal identifiers. This is especially relevant, as the scope of data practices and tool support in games continues to expand [4]. Playtesting in this project consisted of sending the prototype to participants and collecting their feedback via an anonymous questionnaire. This approach was based on informed consent, reduced the amount of data collected, and provided a clear description of how the results would be used. Remote and asynchronous playtesting was selected as a practical method for collecting feedback efficiently within the project scope. However, this method also meant that participants needed suitable hardware and enough familiarity with digital games to complete the test independently, which may have shaped who could take part and what kind of feedback was collected. As needed, AI tools supported the implementation process during development, such as suggesting approaches for specific features and assisting with debugging and bug fixing. The developers remained responsible for all final code and design decisions.

2

Background

2.1 Metroidvania World Structure

Metroidvania games are generally characterised as exploration games in large interconnected worlds, which are opened progressively as the player gains new skills or knowledge. As illustrated in the map of *Hollow Knight* [5], see Figure 2.1, with its intricately connected regions such as Soul Sanctum, Watchers Spire, and Kings Station linked through branching horizontal and vertical pathways, the spatial structure exemplifies the dense interconnectivity and recursive exploration characteristic of Metroidvania design. Instead of following a linear path, such games are based on the repeated exploration of the same space, where the player can view previous locations in a new way with the acquisition of new abilities. It has been found that this structure makes Metroidvania games stand out from more linear platformers, with non-linear navigation and recursive exploration as the prominent gameplay loops [6].

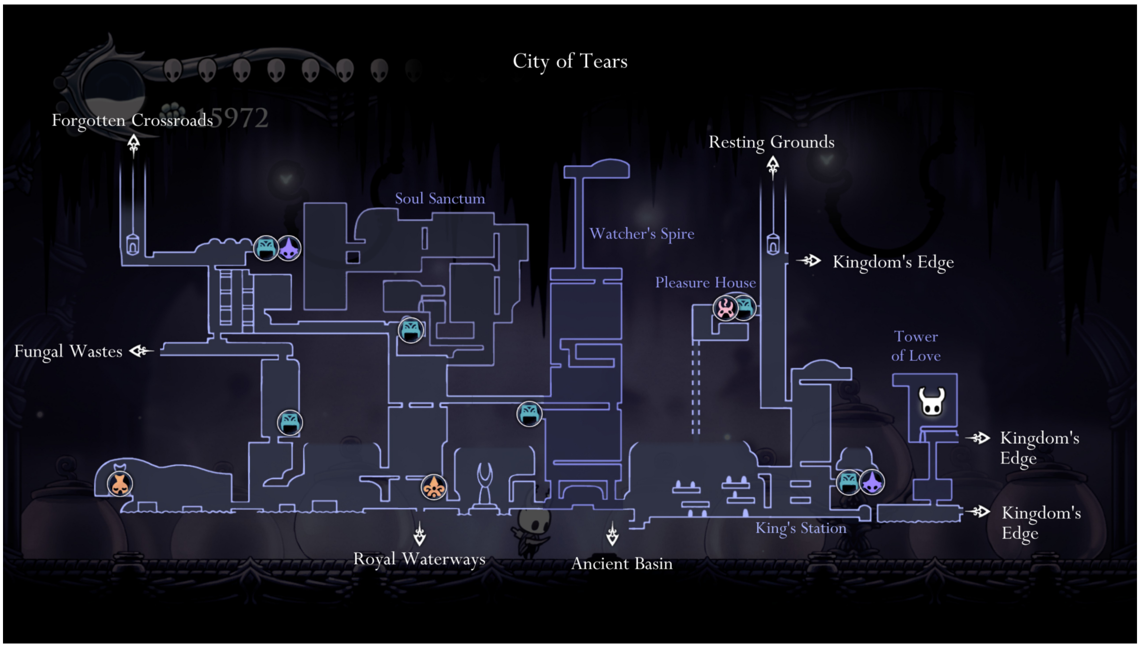

Figure 2.1: Interconnected map view of City of Tears in Hollow Knight.

2.2 Ability Gating and Backtracking

In Metroidvania worlds, players revisit areas repeatedly as new abilities change what they can access, and this progression is often organised through ability-gated obstacles [2]. These barriers can be encountered early on, but later shift from obstacles to passable routes as the players capabilities expand. For example, the Omega Cannon sequence in *Metroid Dread* [7] allows Samus to temporarily gain the power needed to break through a previously impassable Central Unit door. Other researchers have tried to formalise this process by defining backtracking as a mechanical association between the locked and unlocked states of a game world [2]. This is necessary to underline the idea that it means not only returning to the space, but is a planned process of interaction between player advancement and level design. Nevertheless, current literature also indicates that when such gates are based on the standard solution, then the players could identify the patterns that lessen uncertainty, and that there is less of the element of discovery when playing the game repeatedly [1][2].

Figure 2.2: Omega Cannon Unlocking Central Unit Door in Metroid Dread.

Structurally speaking, Metroidvania level design can be viewed as a network that becomes accessible with time. Oliveira et al. suggest that genre-specific structure, large-mapped navigation, skill systems, and dynamic access control are characteristic elements of Metroidvania games [1].

2.3 Navigation and Exploration

More studies on navigation within Metroidvania games focus on the fact that passage in space is not only the physical manoeuvres of the player. Navigation has been defined as a multi-stage process which includes selection of destination, route planning and implementation [3]. The player may face different obstacles in each of the stages. As illustrated in *Hollow Knight* [5], see Figure 2.3, vertical layering, hidden pathways, and subtle environmental cues within dimly lit spaces stimulate curiosity-driven exploration, encouraging players to investigate spatial relationships beyond the most direct route. With backtracking, returning to an area can involve new thought processes rather than simple repetition, as players must consider other routes or approaches available to them based on their capabilities. It implies that alterations in the functioning of the abilities might affect not only the players' destinations but also the way they think about movement and decision-making in the game world.

Figure 2.3: Visible Goals and Branching Paths in Hollow Knight.

Studies that emphasize exploration suggest that certain spatial design patterns create information gaps, such as partial visibility, distant goals, or obscured connections, which can draw players into detours that are not the shortest route but increase involvement through discovery and resolution [8]. Similarly, in *Ori and the Blind Forest* [9], see Figure 2.4, the bright distant landmark of the Spirit Tree, the contrast between the illuminated background and darker foreground framing, and the layered depth of the scene guide navigation toward a visible goal while also inviting side movement toward other visible points of interest. The use of environmental information and spatial relationships to trigger curiosity-based exploration is empirically supported, since players tend to investigate how spaces connect when they see blocked passages, unreachable ledges, or partially hidden routes, and this shifts attention from following a single focused path to testing alternative routes and revisiting spaces to resolve what they have seen [8].

Figure 2.4: Navigation and Pathfinding in Ori.

2.4 Limits of Existing Work

Traditional Metroidvania progression models are challenged by games where access depends on player knowledge rather than explicit ability upgrades. The analysis of so-called Metroidvania games points to the fact that learning the mechanics, environmental laws or systemic interactions, as opposed to learning new objects, can form the background of the movement [10]. Though this project does not attempt to replace ability-based progression with knowledge-based gating, it still indirectly determines other paths which can help players redefine spaces, which have already been investigated [2]. It also questions how varied interpretations of abilities can enable re-engagement without compromising mechanical precision.

Backtracking is an aspect of Metroidvania design, and its dependence on ability systems, space structure, and player movement is confirmed in the literature. Previous studies have primarily examined backtracking within the framework of access control and structural progression [1], [2], and little attention has been paid to how the architecture of abilities can be used to diversify solutions to encountered problems. Neglecting the capability structure limits understanding of design. The project builds on such assumptions by hypothetically trying to theorize about the possibility of the more adaptable backtracking experiences afforded by multi-mode player features to be offered, without compromising the readability and structure the genre has rallied around.

3

Theory

This chapter outlines the theoretical concepts used to understand the prototype as a designed system. It focuses on how game rules shape the player experience, how the Aether system's physics-based environmental interactions remain readable, how level structure affects navigation and exploration, and how players reason through feedback and choices. All of these concepts are relevant since the project aims to expand route and obstacle solutions while keeping them understandable within the structure of Metroidvania progression.

3.1 Game Design

This section introduces the design frameworks that connect the prototypes rules, interactions, and player experience. Since this project examines a multi-form ability system, it is important to consider how mechanics influence gameplay over time and how interaction rules remain comprehensible in various situations.

3.1.1 MDA Framework

The MDA framework describes games as interactive systems where rules shape run-time behaviour and player experiences, which affects what players feel and value during play [11]. The MDA framework is divided into three categories: mechanics describe the designed rules and elements, dynamics explain the resulting long-term behaviour when players engage with the rules, and aesthetics define the desired effects on the player experience [11]. The MDA model is useful in examining design problems, such as an example from a Metroidvania game, where small changes in rules can change movement patterns, route planning, and decision-making in repeated traversal.

The MDA viewpoint can be used to explain how a Metroidvania game changes when it offers more than one way to overcome similar challenges. Repeated traversal then becomes less about executing a familiar pattern and more about selecting and assessing alternatives. Route choices can depend on situational factors, such as the players current abilities and their willingness to take risks. At the experiential level, this touches on agency and discovery while also exploring how progression is facilitated by structure and readability [11].

3.1.2 PEP Framework

PEP offers a systematic means of representing physics-based interactions in games, and how systems can be readable despite the size of the interaction network [12]. The structure defines physics as the rules that determine the environment and the environment as the prevailing state in which players operate. The actions of players and the tools they use are the triggers of events. The framework applies to designs grounded in physical consistency across numerous settings, as it enables dialogue about what constitutes an interaction system legible at the rule tier [12]. For example, when a game uses water as an interaction tool, the same rule that water conducts electricity can remain legible across different rooms and puzzles, so players can predict outcomes and apply the rule deliberately instead of treating each obstacle as a separate exception.

Rules of interaction in physics-based games should be coherent in a variety of situations. The model stresses the significance of coherent rules and clear consequences. Vague feedback or inconsistent rules might lead to misunderstandings and make players less confident in the system [12]. Therefore, PEP can be used to clarify the concept of legibility when designing for a broader solution space with more interaction opportunities while ensuring understandable results [12]. In practice, this means describing each interaction with the same elements of the framework to include the physics rule, the environmental state that makes the rule visible, and the player action that triggers it. It also involves checking that the resulting phenomena and the players deductions remain consistent across locations [12]. For example, if an obstacle can be solved in multiple ways, the design will remain legible if each option follows a stable rule that players can recognize from the environment and predict before acting instead of treating each obstacle as a special case [12].

3.2 Level design and Navigation

This section explores how level structure influences navigation, exploration, and backtracking in Metroidvania games. Since the project aims to broaden route choices and solutions to obstacles, it is important to examine how players identify paths, evaluate alternatives, and recognize opportunities for future visits.

3.2.1 Route Choice

Navigation in Metroidvania games can be characterised by repeatedly traversing neighbouring spaces, where the choice of routes can be considered a continuous process of decision-making rather than a single operation. In this manner, a gamer's route choice becomes an element of the game experience, particularly when revisited.

It is possible to define the process of navigation as a sequence of actions taken by the player, such as choosing a destination, a route, and travelling along the route [3]. When the destination is known and the path is always the same, then route selection would be unnecessary, and movement would be monotonous. Meanwhile, when multiple viable paths are available, players need to plan at multiple levels, alternating between immediate movement decisions and longer-term route planning in the game world [3]. For instance, in the Delicate Flower side quest in *Hollow Knight* [5], players are tasked with carrying a fragile flower to a grave in Queens Gardens without being hit. In this case, route choice depends on prior knowledge of enemies, hazards, shortcuts, and safer paths. Backtracking feels more meaningful when route choice remains open rather than collapsing into routine [3].

3.2.2 Progression Clarity

Progression legibility is the ease with which the players can perceive what they can access, what is blocked, and where there is significant choice within the game world as they navigate. When a game has multiple pathways to follow, it is essential for players to be able to compare options while distinguishing the main progression from the optional routes. Studies have found that in-world cues can support players understanding by helping them stay oriented and indicating routes that are frequently used in a space [13]. For instance, visible traces, such as player-generated paths or repeated route marks, can demonstrate which paths are commonly taken and help players understand how a space is typically navigated. Nonetheless, excessive cues can cause visual clutter, which lowers the level of clarity and complicates the interpretation of spaces [13]. When too many route traces overlap at the same junction, players may have difficulty determining which route is relevant to their current goal. In a Metroidvania game, cues should emphasize the main flow and a few significant options while avoiding the inclusion of excessive information on the screen so that players can recognize meaningful routes and develop a stable mental map.

3.2.3 Exploration Patterns

Exploration can be triggered by curiosity, and level design can create curiosity by indicating the existence of gaps in information via patterns. Patterns of level design connected to curiosity-driven exploration include reaching extreme points, resolving visual obstructions, interacting with out-of-place objects, and understanding spatial relationships [8]. Each pattern offers a different kind of invitation. Extreme points and obstructions encourage players to move toward vantage points and seek answers to things they can not currently see. Out-of-place elements encourage examination and experimentation. Spatial relationships motivate players to construct a mental map and observe the relationship between spaces. For example, in *Hollow Knight* [5], players are often faced with visible but unreachable ledges, blocked passages, and distant platforms that encourage them to remember the space and return later with new movement abilities. In *Ori and the Blind Forest* [9], bright, distant landmarks and layered paths draw attention beyond the immediate route, prompting players to wonder how different areas connect.

Such patterns of level design can prove useful in a Metroidvania prototype with a backtracking, multiple-obstacle-based structure. It offers means of placing cues that can be read upon revisiting. Obvious barriers, conspicuous areas of interest, and unique environmental features can be used to indicate what can have value in the future. It helps in early exploration and re-exploration and keeps players on track

[8].

3.2.4 Layout and Secondary Tasks

Spatial exploration may be regarded as an object of design, which is guided by the layout structure, as opposed to randomness [14]. As pathways split, reunite, and reveal new facts over time, players tend to do more than follow the shortest line, because the space keeps offering plausible unknowns of importance. It is important in Metroidvania design, since backtracking is frequently part of the core loop.

Moreover, tasks and rewards may rival exploration and influence the player's movement through a space [15]. When players are busy with a second task, they might concentrate on effective gathering or accomplishment and cut the duration they use in testing alternative paths and identifying alternative opportunities. For this project, the implication is that optional activities need to correspond with the desired experience of exploration. Tasks can compromise the variety of routes and decrease the importance of multiple solutions when they focus attention excessively.

3.3 Player Reasoning

This section focuses on how players understand and manage the options created by a multi-form ability system, such as breaking barriers, traversing narrow spaces, and activating vertical devices. If the prototype offers several paths or solutions to obstacles, players should be able to understand what each option means, predict what may happen when they use it, and choose between alternatives without becoming overwhelmed. Choice and exploration become meaningful when rules are consistent, feedback is clear, and the number of active decisions remains manageable.

3.3.1 Learning through Feedback

Multi-form ability systems are based on players developing expectations regarding what each form is capable of and at what time to employ it. Physics-based games do not explicitly describe many rules, and players must develop an understanding of the system through observation of phenomena and experimentation with the environment [12]. In this way, player learning is based on feedback and consistency. When repeated game responses can be predicted, players deduce rules and act without speculation [12].

Constant feedback also helps in the transfer of learning through contexts. As players understand how an interaction will behave in one scenario, they are able to use that knowledge in new challenges and paths. It assists multi-option designs to be comprehensible. In this project, the ability forms should generate clear signals that can be used to infer what changed, why it changed, and how to proceed, ensuring that the expanded range of routes and obstacle solutions does not diminish clarity [12].

3.3.2 Choice and Cognitive Load

Choice has the potential to enhance players' agency, but it also obliges them to make more comparisons before acting. Players need to weigh and evaluate more options with their existing objectives in the event of numerous potential paths or solutions. This may increase cognitive load, and the decision-making process may become more laborious, although the underlying movement may be easy [3]. The danger is more evident in games where navigation is repeated since the players need to repeat the same decisions when returning to the same level [3].

At the level design perspective, exploration is the management of information gaps through a level design. Players need a clear reason to take an alternative path and a legitimate ground to decide whether it is worth the attempt [14]. If the competing tasks are framed as a reward-oriented goal with a narrow focus, players may stop comparing routes and instead use the most efficient one. This is capable of lowering exploration and decreasing the perceived value of numerous options [15]. Similarly, some of the cues designed to facilitate orientation may negatively affect clarity when they become excessive, since additional information makes it more difficult to see what matters [13]. Multi-option traversal should increase meaningful choice without overwhelming players with information.

3.4 Design Framing for the Prototype

Games in the Metroidvania genre are known for interconnected worlds and ability-gated progression [1]. Players return to earlier areas after gaining new movement or interaction abilities, which allows previously blocked spaces to become available. However, when barriers point toward one expected solution, backtracking becomes less useful because revisits can feel more like retracing a known path than rethinking the space [2]. The central concern is how a multi-form ability system can offer more open route choices and obstacle solutions while maintaining the readable structure of Metroidvania progression.

The MDA framework provides a useful way to connect the rules of the prototype to the dynamics of route choice, backtracking, player decision making, and the intended experience of agency and discovery [11]. The PEP framework gives a more specific way to discuss the readability of interaction rules [12]. If players can understand the physics rule, the environmental state, and the action that produces a result, different solutions can remain understandable rather than feeling like exceptions [12]. This is important for the prototype, since different forms of the same ability are meant to expand the solution space without making the system less readable.

Route choice becomes valuable when players can compare options and plan ahead instead of following a fixed route [3]. Progression clarity depends on cues that show the primary flow and a few important alternatives without giving too much information at once [13]. Information gaps and exploration patterns can help players notice spaces that may become important later [8]. Level structure also matters because layout can shape whether players explore beyond the shortest path or only follow the most direct route [14]. Secondary tasks also need to be controlled because they can take attention away from route reading and reduce exploration [15]. The crucial design points in this project are consistent ability rules, readable obstacles, visible but limited alternatives, and revisitable routes that create new decisions without overwhelming the player.

4
Methods

This chapter describes the methods used to design, develop, and evaluate the prototype. The project followed a Research through Design approach supported by comparative game analysis, iterative prototyping, two rounds of playtesting, and a post-play questionnaire. The questionnaire responses were used to examine participants' reported experiences of progression clarity, Aether-form use, control, feedback, exploration, and backtracking. GameFlow informed the reflective discussion of selected player-experience concerns but was not used as a validated measurement instrument. Basic accessibility considerations were addressed through control clarity, readable cues, and consistent interaction feedback.

4.1 Research through Design

The methodological approach adopted in this thesis was Research through Design (RtD), in which knowledge is developed through the creation, examination, and revision of a designed artefact. Rather than testing a predetermined causal hypothesis, the project used an exploratory process to investigate how specific ability- and level-design decisions related to progression, route reading, and backtracking. The design process was therefore treated as a form of inquiry in which understanding emerged through prototyping, reflection, and iterative revision [16]. In this project, the artefact was a playable Metroidvania prototype built around Liquid, Solid, and Gas Aether interactions.

As part of the Research through Design process, a comparative analysis of *Hollow Knight*, *Metroid Dread*, and *Ori and the Blind Forest* was conducted before the main prototype iterations. These games were selected because they provide relevant examples of interconnected world structures, ability-dependent access, environmental guidance, shortcuts, optional paths, and repeated traversal. The analysis focused on examples of ability gating, route reopening, shortcuts, barriers, optional paths, and repeated traversal. Particular attention was given to how newly acquired abilities changed access to previously encountered spaces and how revisiting could either create new spatial decisions or repeat an already known route.

This was an exploratory design analysis rather than a formal comparative evaluation of the selected games. Its purpose was to identify design patterns relevant to the research question and to inform the initial roles of the Aether forms, the placement of ability-dependent obstacles, and the structure of optional and revisitable routes.

The prototype was developed through three main design iterations. The first iteration established the initial ability concept and explored Liquid Aether as the primary interaction mechanic. The second iteration separated Aether into Liquid, Solid, and Gas forms in order to create more distinct environmental roles. The third iteration integrated the three forms into obstacle placement, progression routes, optional paths, and revisit sequences.

Changes to abilities, level layouts, and environmental objects were reviewed throughout development in relation to the research question. The knowledge produced through this process was therefore specific to the artefact and its development context rather than predictive or universally generalisable [16].

Reflective analysis was used to document design decisions, prototype changes, and the relationship between the intended design and the questionnaire responses. Theory was used during development to frame design decisions and after playtesting to interpret the completed artefact. The prototype and its supporting documentation were treated as research outputs, while the written analysis distinguished between design intentions, implemented features, participant-reported experiences, and limitations of the available evidence [16].

4.2 Playtesting Procedure

Participants were recruited through the researcher's academic and personal networks. Participation was voluntary, and participants received information about the purpose of the study, the playtesting procedure, and the use of their questionnaire responses before taking part. Each participant accessed the relevant prototype version remotely, completed the playtest independently, and submitted the post-play questionnaire after playing.

Two rounds of remote and asynchronous playtesting were conducted after the initial level structure and the three Aether forms had been integrated into a playable prototype. The first round involved six participants and used this initial integrated version. It collected feedback on movement, control feel, interaction feedback, level readability, progression clarity, Aether-form use, and backtracking.

Following the first round, the prototype was revised in response to the questionnaire feedback. The revisions focused primarily on level guidance, interaction communication, movement and control feel, and the presentation of ability-related information. The second round involved eight participants and used this revised version of the prototype. It examined participants' reported experiences of the updated controls, level communication, Aether-form interactions, route distinction, progression clarity, and backtracking.

After playing, participants completed a post-play questionnaire developed for this project. The questionnaire contained closed-ended and open-ended questions concerning play completion, familiarity with similar games, progression direction, route distinction, meaningful backtracking, Aether-form understanding, control feel, interaction feedback, strengths, and areas for improvement. The complete list of questions is provided in Appendix A.1.

4.3 Questionnaire Data Analysis

The questionnaire contained both closed-ended and open-ended questions. Closed-ended responses were summarised using participant counts and percentages. Open-ended responses were translated into English where necessary and reviewed for recurring topics related to progression direction, optional-route motivation, Aether-form use, control feel, route guidance, interaction feedback, strengths, and suggested improvements.

The grouping of open-ended responses was descriptive rather than a formal thematic analysis. Individual responses could be associated with more than one topic when they contained several ideas, so the resulting categories were not treated as mutually exclusive.

The analysis focused on participants' self-reported experiences. Gameplay was not directly observed, and no route telemetry, interaction logs, or recordings of failed actions were collected. The study therefore could not determine participants' exact routes, when misunderstandings occurred, or how frequently specific interaction failures happened.

4.4 GameFlow

GameFlow was used as a secondary reflective framework for discussing selected aspects of player experience, particularly control, challenge, clear goals, feedback, and player skills [17]. It was not used as a validated questionnaire scale, a scoring system, or the primary structure for coding participant responses.

Instead, the custom questionnaire was organised around concerns specific to the prototype and research question, including progression clarity, route reading, backtracking, Aether-form understanding, control feel, and interaction feedback. GameFlow concepts were used where relevant to relate these prototype-specific findings to broader concerns about clear goals, control, feedback, challenge, and the relationship between required actions and player skills. Consequently, the analysis reports the questionnaire results by question and topic rather than calculating GameFlow scores.

4.5 Accessibility

Accessibility was treated as a secondary design consideration rather than as the primary object of evaluation. The project did not conduct a complete accessibility assessment. Instead, development focused on basic aspects of readability and playability, including visible environmental cues, understandable interface information, consistent interaction feedback, and stable control mapping. These concerns relate to the GameFlow dimensions of control, feedback, and clear goals because they influence whether participants can understand available actions and interpret their consequences [17].

Because the prototype uses several forms of one ability, particular attention was given to the communication of the selected Aether form and the distinction between form-specific interactions. These elements were reviewed during iterative development and were also addressed in questionnaire items concerning Aether-form understanding, control feel, interaction rules, and feedback. However, the project did not implement or evaluate a complete set of accessibility features, such as remappable controls, alternative input methods, adjustable visual cues, or broader assistive options.

5

Execution

This chapter describes how the design concepts were translated into a playable prototype and explains the rationale behind the main design and implementation decisions. Because the project investigates a multi-form ability system in relation to progression and backtracking, the prototype combined ability rules, environmental interactions, obstacle logic, feedback, and player learning within one playable artefact.

The chapter first describes the development of the Aether ability system, from the initial Liquid Aether experiment to the final three-form interaction structure. It then explains the design documentation and implementation processes that supported the prototype, including player controls, form switching, environmental object behaviour, interface elements, and interaction feedback.

5.1 Design Documentation and Parallel Development

During the early development stage, the main design documentation was created in relation to the theoretical framing of the project. It covered game design, system design, level design, and narrative design. The game and system design documentation defined the core gameplay structure, the Aether system, and the main interaction rules, while the level and narrative documentation described how player abilities, progression, and backtracking were represented through spatial structure and environmental context.

These areas were developed in parallel rather than as separate sequential tasks. Changes to the Aether system affected obstacle design and route structure, while changes to the level layout created new requirements for interaction rules, visual communication, and implementation. Developing the documentation and prototype together allowed feedback to move between conceptual design and technical implementation throughout the project.

The resulting design rationale, system structure, level progression, and supporting documentation are summarised in the Game Design Document provided in Appendix B.

5.2 Ability System

The final prototype is a small-scale 2D Metroidvania game in which the player explores an interconnected environment and gradually gains access to three forms of a single ability called Aether. In the prototype, the player controls a character who remains physically separate from Aether. Aether is a material that the character can generate, release, and manipulate. Selecting a form changes the type of Aether used and the environmental interactions available; it does not transform the character into Aether. Liquid Aether is released to interact with liquid-sensitive mechanisms and environmental objects. Solid Aether is generated as a throwable projectile used to break barriers. Gaseous Aether activates air-based or vertical mechanisms that allow the character to access elevated routes. The forms are introduced through progression and are used both to overcome environmental obstacles and to access alternative routes. As new forms become available, the level provides opportunities to revisit previously explored areas, open blocked passages, reach optional locations, and approach familiar spaces through newly available interactions. The prototype was therefore designed to examine whether multiple forms of one ability could broaden route and obstacle possibilities while keeping progression understandable.

5.2.1 Design Aim and MDA Framing

The ability system was developed specifically for the prototype rather than being defined at the beginning of the project. Its primary design goal was to create a consistent and easy-to-understand set of interaction rules that could support route variation and meaningful backtracking within a relatively small Metroidvania-style area. Instead of providing the player with several unrelated tools, the design centred on a single material, Aether, that could take three distinct physical forms. This concept established the overall direction of the prototype, which explored how the relationships between these forms could influence player movement, environmental interaction, route choice, and backtracking.

This design goal was connected to the role of ability-gated progression in Metroidvania games. Newly acquired abilities can change how previously encountered spaces are understood by opening routes or revealing new environmental functions [1], [2]. The prototype therefore combined newly accessible paths with reinterpretations of existing spaces. For example, a previously blocked passage could later be recognised as a Solid Aether interaction, while a vertical space could become accessible after Gas Aether was acquired. Revisiting was therefore designed as an opportunity to apply newly available interaction rules to familiar environments rather than simply repeat an earlier traversal.

MDA was used to frame the relationship between the implemented rules and the intended player experience. At the mechanics level, each Aether form was assigned a distinct environmental function and a consistent set of interaction rules. At the dynamics level, these mechanics were intended to support obstacle interpretation, form selection, route reconsideration, and revisiting previously encountered spaces. At the aesthetics level, the intended experience centred on curiosity, exploration, and rediscovery [11].

The development process therefore moved from the early Liquid Aether experiment to the separation of Liquid, Solid, and Gas forms, followed by their integration with environmental obstacles, progression conditions, and revisit opportunities.

5.2.2 Initial Ability Concept and Early Liquid Test

The project began with the intention of developing one coherent ability system rather than a collection of unrelated tools. Aether was therefore conceptualised as a single material that could later take several physical forms. This approach was intended to make the forms understandable as related parts of the same system while still allowing each form to support a distinct environmental function.

The first prototype experiment focused on Liquid Aether. At this stage, the purpose was not to implement the complete ability system, but to investigate whether Aether could function as a physical and interactive material within the game world. The test examined how Liquid Aether was generated, how it moved through the environment, and how it affected nearby objects. Because interactions require readable relationships between player input, system response, and environmental change, this experiment provided an initial basis for evaluating the material concept [12].

Figure 5.1 shows the early Liquid Aether experiment. The test represented an initial technical and design exploration rather than evidence that the complete multi-form system was already effective.

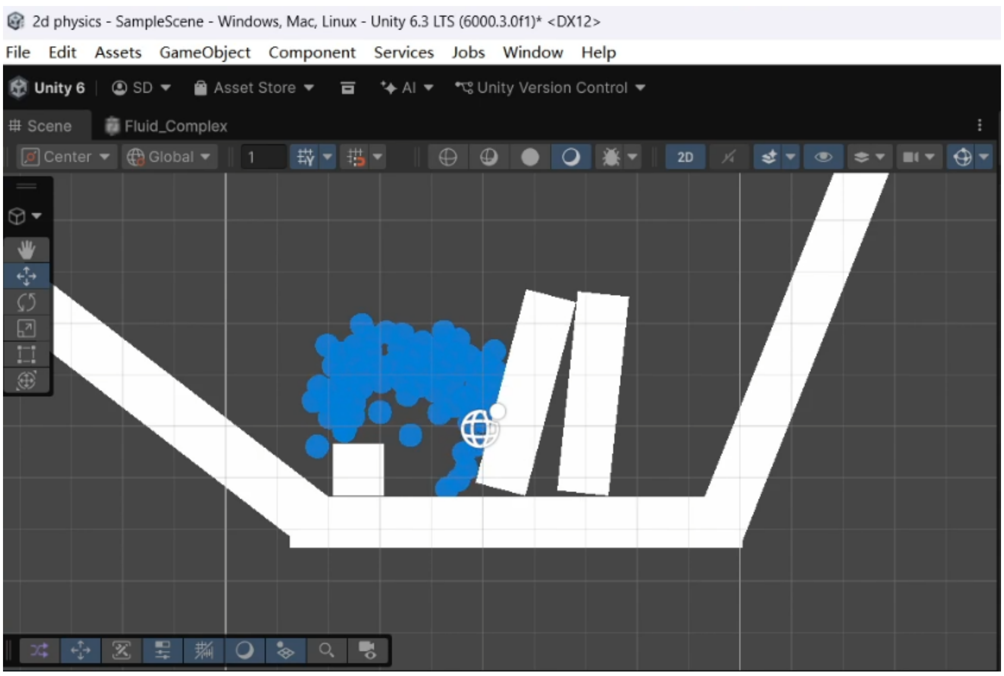

Figure 5.1: Early Liquid Aether test showing the projected liquid effect.

Based on this initial test, Aether was selected as the foundation of the ability system because a single material with multiple physical forms could support several types of interaction without requiring unrelated player tools. This concept was developed into Liquid, Solid, and Gas forms, each associated with a distinct movement or environmental function. Together, the forms were intended to provide alternative ways of traversing the level, overcoming obstacles, and accessing previously unavailable routes.

5.2.3 Form Separation and Iterative Refinement

After the initial Liquid Aether test, the next stage focused on distinguishing the three forms more clearly. The early experiment established that Aether could function as an interactive material, but visual differences alone were not sufficient. A system in which the forms looked different but did not have predictable functions would have encouraged trial-and-error selection rather than readable decision-making.

The second stage thus centred on the differentiation of forms, according to their mechanical functions. Liquid Aether was refined as a manipulable fluid used to fill spaces, move environmental objects, and activate liquid-based mechanisms. Solid Aether was developed as a throwable solid projectile used to apply force and break barriers. Gaseous Aether was designed to interact with vertical devices and air-based mechanisms that enabled the character to access elevated routes. This provided the forms with more sense of relation to the obstacles they are corresponding to. Environmental features were designed to suggest the relevant Aether form. Fluid-based mechanisms and spaces requiring liquid flow indicated Liquid Aether, breakable barriers indicated Solid Aether, and vertical devices or elevated routes indicated Gaseous Aether.

From an MDA perspective, this stage refined the mechanics so that each form could be associated with recognisable environmental cues and predictable interaction outcomes. The intended dynamic was for players to use information in the environment when selecting an Aether form rather than relying entirely on random experimentation.

Cracked barriers were associated with Solid Aether, fluid-sensitive mechanisms with Liquid Aether, and vertical devices or elevated openings with Gaseous Aether. These visual and spatial associations were intended to support curiosity and discoverability while maintaining readable interaction rules [3], [8], [13].

5.2.4 Final Ability Forms and Interaction Logic

The final ability system consists of three forms of Aether that the player character can generate and use. Liquid Aether behaves as a manipulable fluid that can fill spaces, affect movable objects, and activate liquid-sensitive mechanisms. Solid Aether is generated as a throwable projectile that applies force and breaks designated barriers. Gaseous Aether interacts with air-based and vertical devices, enabling the character to access elevated routes. Each form therefore provides a distinct type of environmental interaction while remaining part of the same material-based ability system.

The most significant changes during this second phase were in introducing these skills to the design of obstacles and routes. If there was an obstacle that was solid, it meant Solid Aether. If there was a passage that indicated flow or pressure, it meant Liquid Aether. If an area contained a vertical device or an elevated route, it indicated a possible use of Gaseous Aether. These associations provided players with environmental clues about which Aether form was likely to be effective. The ability system is not based on a large set of rules that are presented to players, but rather a small set of rules that interact dynamically with the environment.

Some routes were designed as sequential multi-form challenges that required the player to use different Aether forms in a specific order. As shown in Figure 5.2, the route is designed around a sequence of two form-specific interactions. The barrier must first be broken using Solid Aether. After the route has been opened, Liquid Aether is required to activate the mechanism and open the way forward. This example shows how different Aether forms are combined sequentially within a single route. This sequence combines two existing form-specific rules without introducing an additional interaction type. It also illustrates how a route can remain unavailable until the required forms have been acquired. When the player later returns with the relevant forms, the previously blocked space provides a new interaction sequence. This was intended to support recursive exploration and the reinterpretation of previously encountered areas [2], [6].

Figure 5.2: Example of a sequential multi-form route

Multiple Aether functions were tested in the same environment in a later test scene, as shown below in Figure 5.3. The test shows the player character generating and throwing Solid Aether toward a breakable object. The impact of the Solid Aether destroys the object. Liquid Aether and Gaseous Aether interactions were also included in the test scene. This stage extended the prototype beyond a single physical effect by integrating multiple forms with obstacle interactions and predefined route conditions.

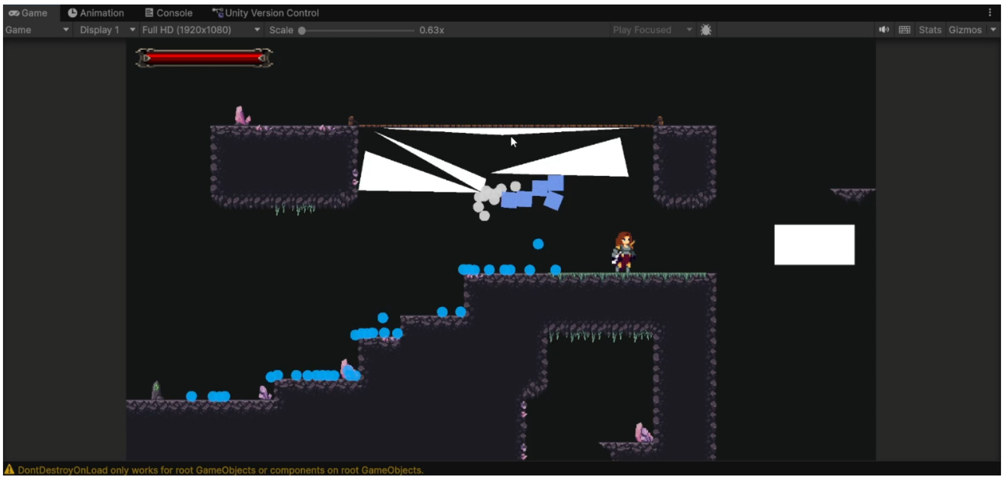

Figure 5.3: Multi-form ability test showing Solid Aether breaking an obstacle.

5.2.5 Interaction Feedback and Rule Readability

Once the three Aether forms had distinct environmental roles, the prototype required feedback that communicated the selected form, the outcome of an interaction, and the reason an attempted interaction did not succeed. Visual effects, animation, sound, and interface information were therefore used to support recognition of the active form and the resulting environmental response.

Consistent responses were required so that interaction knowledge could be transferred between different parts of the prototype. A Frostrock barrier that responded to Solid Aether in one location was therefore designed to respond in the same way elsewhere. Similarly, Liquid-sensitive mechanisms and Gas-based vertical devices followed repeated visual and mechanical rules [12].

Unsuccessful interactions were also intended to remain legible. For example, using Liquid Aether against a barrier designed for Solid Aether should produce feedback that distinguishes an inappropriate form from a technical failure or missing input. In this way, unsuccessful attempts could still communicate information about the system rules and support later reconsideration of the environment.

5.2.6 Summary and Scope Decisions

The Aether mechanics were implemented as a proof of concept for examining multi-form ability design, progression, and backtracking rather than as a complete ability system for a commercial game. The scope was deliberately limited to three forms and a small set of repeated environmental interactions. This made it possible to investigate relationships between form identity, obstacle rules, route conditions, and revisit opportunities without introducing a large number of unrelated abilities.

The ability system developed through three main stages. The first explored the physical and interactive potential of Liquid Aether. The second separated Aether into Liquid, Solid, and Gas forms with distinct environmental functions. The third integrated these forms with obstacles, route conditions, and environmental cues.

This limited structure provided a manageable basis for evaluating how a related set of abilities could support environmental reinterpretation and route variation.

5.3 Level Design

5.3.1 Spatial Structure

The level moves through a series of vertical layers, from the island surface into the flooded interior, then to the Sanctuary Nexus, the lower sanctuary spaces, and finally the Sanctuary Core. Each layer represents a deeper part of the same world rather than a separate stage, and access to side regions changes as new forms of Aether are gained. As shown in Figure 6.3, the topology map shows the main downward route from the Island Surface to the Sanctuary Core, together with side regions that reconnect to the central route through Aether-based conditions. The prototype keeps the recursive exploration of Metroidvania spaces while still having an easily navigable route within a small scope [1][6].

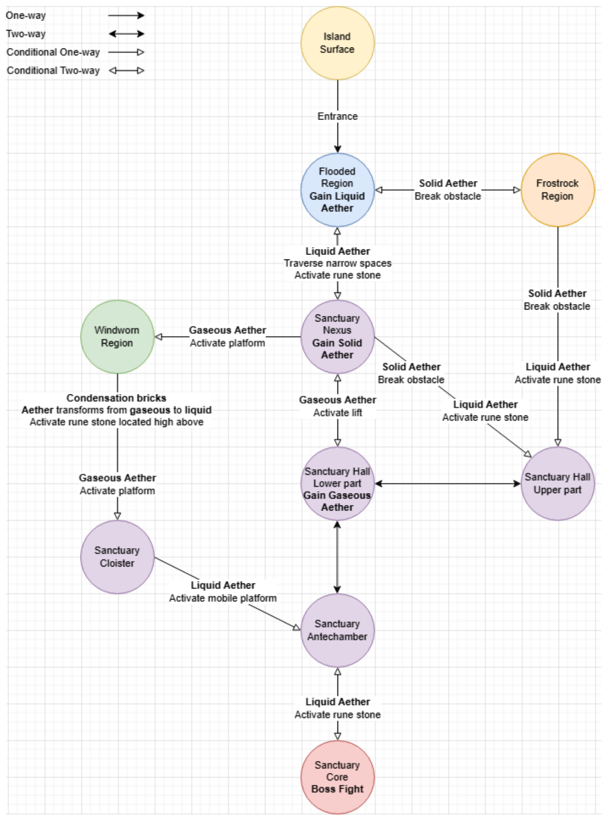

Figure 5.4: Level topology map showing region connections, Aether acquisition order, and ability-gated routes.

The Sanctuary Nexus is the first main anchor area, while the Sanctuary Antechamber becomes a later connecting area before the final descent into the Sanctuary Core. The Frostrock and Windworn areas are not separate side levels, but side routes that remain close to the main route. When the player receives the corresponding

Aether forms, these areas become meaningful parts of the progression. The player first enters the Flooded Region and then reaches the Sanctuary Nexus. Later areas do not replace earlier ones. Instead, previous spaces remain connected to later routes and can gain new meaning once certain Aether forms are acquired. This draws inspiration from *Hollow Knight* [5], where previously visited areas still have significance because new abilities and route knowledge change the way the world is understood.

The structure was designed to provide players with a few meaningful route options while maintaining a clear sense of direction toward the Sanctuary Core. Research indicates that in Metroidvania games, player navigation is not only about physically moving through the world but also requires the ability to choose destinations, compare routes, and plan through interconnected areas [3]. This level uses a few well-connected areas instead of many loosely connected ones. The Sanctuary Nexus and the Sanctuary Antechamber offer anchor points that connect various paths and reduce disorientation. Side areas are adjacent to the main route and serve as visible intermediate goals rather than distant side paths.

5.3.2 Obstacle Design and Gating

Obstacles are not designed in reference to a single environmental condition and a single dominant form-based response, but rather according to a relationship of one of each. The first areas in the Flooded Region are devoted to pits and rune activation via Liquid Aether. Spaces are later introduced with Frostrock barriers that are broken with Solid Aether, and vertical devices that are activated with Gaseous Aether. The study of ability gating indicates that problems without obstacles are not as interesting when the obstacles are set directly toward a known, repeated solution. The design is consistent with regard to the variety of gates, and the sense of earlier spaces is slowly changing over time [2]. The aim was not to remove the gating but to make it more easily understood and useful for subsequent reinterpretation. It is relevant to backtracking into the Flooded Region since the area initially introduces Liquid Aether through pits and rune activation, and later contains visible rewards and a Solid Aether gate, which makes the same space meaningful again.

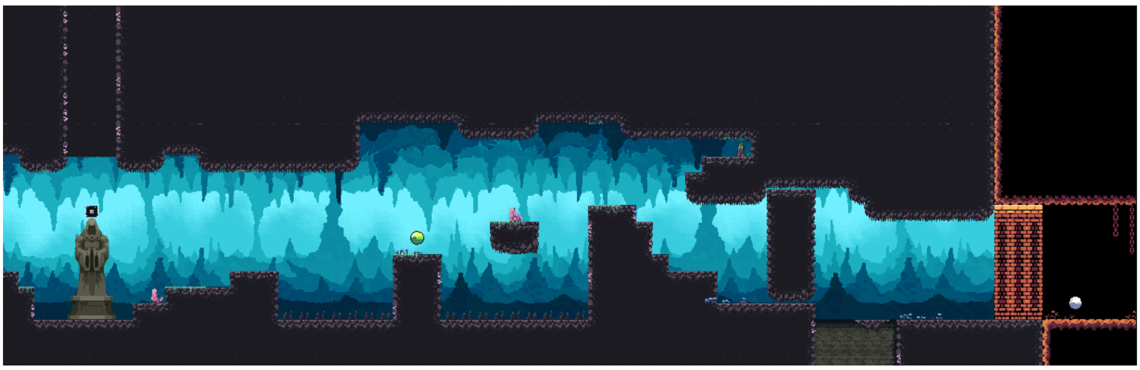

Figure 5.5: Flooded Region with Liquid Aether teaching spaces, optional rewards, and a later Solid Aether gate.

These barriers are also planned with the requirement for consistency and progressive learning in mind. The research also indicates that players develop expectations based on the rules' application, and that the choice of paths is meaningful when there are identifiable reasons to choose a different path[12][14]. The obstacles presented do not change from one point to the next. When reappearing, Frostrock barriers look the same; when rune stones reappear, they have the same activation rules. Exploration is rewarded with small combat bonuses and recovery bonuses. These rewards are secondary and help facilitate variation along the route without overwhelming the progression of the main route [15].

5.3.3 Revisit Routes and Alternative Paths

Revisiting is a part of the main progression. The former section that connected to the Frostrock Region opens when the player enters the Sanctuary Nexus and gears up with Solid Aether. Subsequently, with the use of Gaseous Aether from the Sanctuary Hall, the level unlocks a previous junction, making the Windworn and Cloister paths a new side loop. Backtracking is a reevaluation of space. It's consistent with the concept that route planning should be active if the player visits an earlier area in Metroidvania games[2][3].

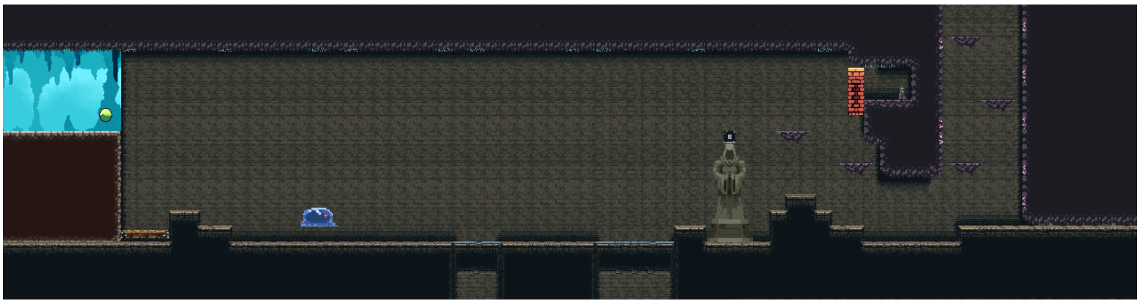

Figure 5.6: Sanctuary Nexus with anchor space and route connections.

Alternative solutions in this prototype will not be totally open in terms of design. It provides a small set of route differences influenced by execution requirements, visibility, and time cost. When the main route is clear, players can go to the lower sanctuary spaces directly or proceed to side areas for optional rewards and/or perhaps safer preparation before heading back onto the main route. Studies have demonstrated that route choice is meaningful when there are several available choices, but when there are too many competing tasks, the value of the exploration may become insignificant, because of the distraction from the main spatial question [14][15]. This is why there are optional revisits near the core path in this level that are connected to the same world logic. While the design encourages decision-making, it does not attempt to become an expansive, interconnected network like *Hollow Knight* [5], where numerous regions are linked by multiple loops, entrances, and shortcuts. The prototype keeps route variation close to the main path so players can make choices that matter without losing the overall direction of progression.

Figure 5.7: Frostrock Region with side route and optional reward path.

5.3.4 Level Flow and Progression Clarity

The overall level flow is directed towards a long-term goal, the Sanctuary Core, and a series of local, readable goals. The path to the core is broken up into transitions that the player can recognize in play. Statues mark important interaction or ability points, regional visual changes separate flooded, sanctuary, and Frostrock spaces, and visible obstacles such as Frostrock barriers or vertical shafts indicate places that require a later Aether form. Research indicates that progression clarity relies on players' understanding of the blocked, available, and meaningful choices throughout the progression, as well as the progression's trajectory [3][13]. The level starts off with less branching, then adds more complexity to the routes. It has a gradual increase in complexity after the player has developed a solid foundation of the world.

As illustrated in Figure 5.8, the primary pathway remains close to the focus areas of the sanctuary while the side areas and optional paths are located close to the primary flow areas. The image shows how the players can move from the surface and flooded areas to the structure of the sanctuary. Future targets are set without making the level an open network of rewards by having nearby branches and visible reward points.

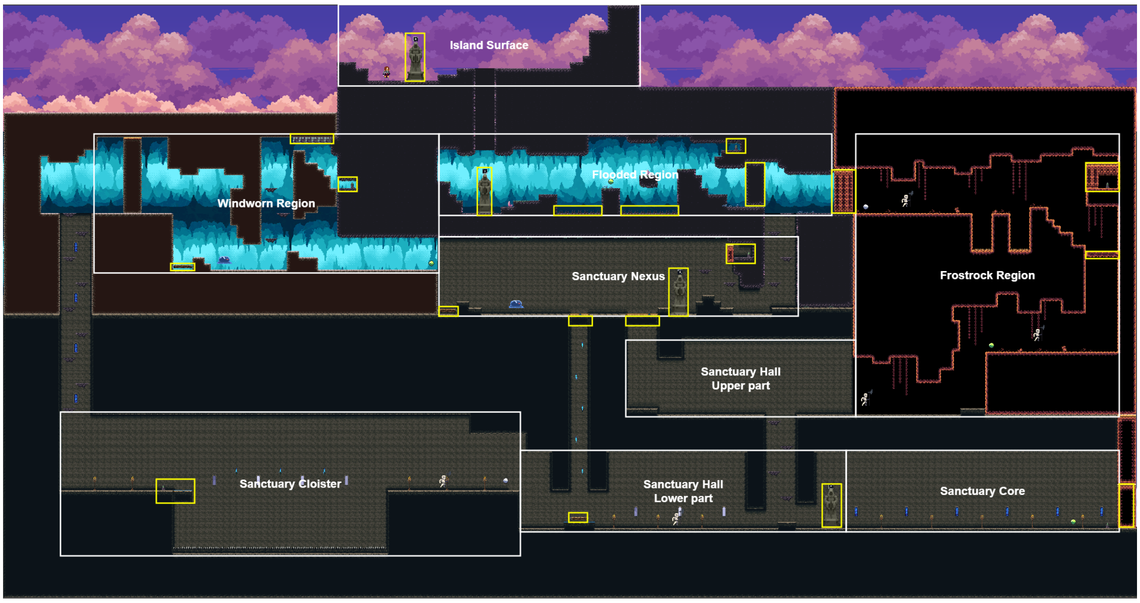

Figure 5.8: Overall level layout with marked regions, route connections, and ability-gated interaction points.

The layout and contrast create environmental guidance. Optional regions are also shown before they become usable, which is commonly found in Metroidvania games where earlier spaces can gain new value after the player receives new abilities [1][6]. In this prototype, visible side spaces and blocked routes help the player remember possible future goals when a new form of Aether is acquired. Reward items are arranged to draw attention to these optional targets, for example, by placing bonuses near side routes or behind ability-based obstacles, but not in a way that takes focus away from the main route. Research also indicates that spatial relations, occlusion of sight and clear differences in the environment spark players' curiosity-driven learning and exploration of potential opportunities beyond the most obvious ones [8]. The design isn't too complicated because there are not several conflicting clues in a single moment. The main path is visually connected through the main structure in the middle. In contrast, optional paths require more comparison and inference because they are marked by rewards, blocked passages, or ability-dependent access. The main path is direct with clear feedback, while the optional paths require the player to read the environment more carefully. It is desirable to expand the solution space without making the progression of the prototype too difficult to follow.

5.4 Implementation and Supporting Systems

This section describes how the main design concepts were implemented in Unity through player controls, form states, environmental object behaviours, interface elements, and in-world feedback. The goal was not to create a production-ready technical architecture, but to produce a stable research prototype containing the interactions required to investigate the research question.

Implementation proceeded incrementally. Core actions such as movement, jumping, interaction, combat, ability use, and form switching were established first. The Aether forms were then connected to environmental objects through form-specific response rules. Finally, interface elements and environmental indicators were added to communicate controls, the current resource state, and interaction outcomes. From an MDA perspective, these mechanics were implemented to support the intended dynamics of obstacle interpretation, exploration, and revisiting [11].

5.4.1 Player Controls and State Management

Player controls were limited to the actions required for testing the prototype's core mechanics: movement, jumping, combat, interaction, ability use, and switching between Aether forms. Limiting the number of actions was intended to reduce control complexity and keep the evaluation focused on navigation and form-based environmental interaction.

State management was required to track both the movement state of the player character and the currently selected Aether form. The character could move through the level normally, approach an interaction point, select an appropriate Aether form, and then generate or release that form to overcome the obstacle. The system tracked the selected Aether form and used it to determine both the Aether that was generated and the response of environmental objects. For example, when Liquid Aether was selected, the generated material behaved as a liquid, and lightweight objects could float when they came into contact with it.

The interaction system followed a rule-based structure to make the outcomes predictable. When Liquid Aether was selected, the character could release it to affect liquid-sensitive environmental elements, such as pushing movable objects or filling designated spaces. Solid Aether could be generated and used to apply force, including breaking designated barriers. Gaseous Aether interacted with vertical or air-based mechanisms that enabled the character to access elevated routes. These rules established a consistent relationship between the selected Aether form, environmental objects, and the feedback produced by each interaction[12].

5.4.2 Form-Based Interaction Implementation

The prototype was created as a small-scale 2D research artefact in Unity. The primary implementation challenge was to integrate the Aether forms, player actions, obstacle behaviours, and level progression into a coherent gameplay system. Obstacles were therefore implemented with form-based interaction rules, meaning that they responded to the type of Aether generated or used by the player character.

For instance, a blocked route could be affected in different ways depending on the selected Aether form. Liquid Aether could push an obstacle or fill a pit, Solid Aether could destroy a barrier, and Gaseous Aether could activate or support access to a higher route. As a result, the same area could present different possibilities depending on the Aether form available to the player and the players prior knowledge of the level. From a design perspective, this supports the idea that revisiting a space can involve reinterpreting it rather than simply repeating the same traversal [2][1].

This implementation structure also supported later refinements. The level layout could remain unchanged while the interaction rules of individual objects were modified. For example, an object originally designed to be pushed could instead be changed into a breakable object without requiring the surrounding level geometry to be rebuilt. This made it easier to determine whether a problem resulted from the level design, the interaction rules, or the players understanding of the currently selected Aether form. In Figure 5.9, a middle-stage prototype test was used to connect ability interactions with level navigation. During this test, Liquid Aether was used to lower a blocking obstacle and fill a pit, allowing the player character to proceed toward a higher route. This stage was significant because the ability was no longer tested only as an isolated effect. Instead, it was integrated into a playable path in which the player could use Aether to manipulate the environment and progress through the level.

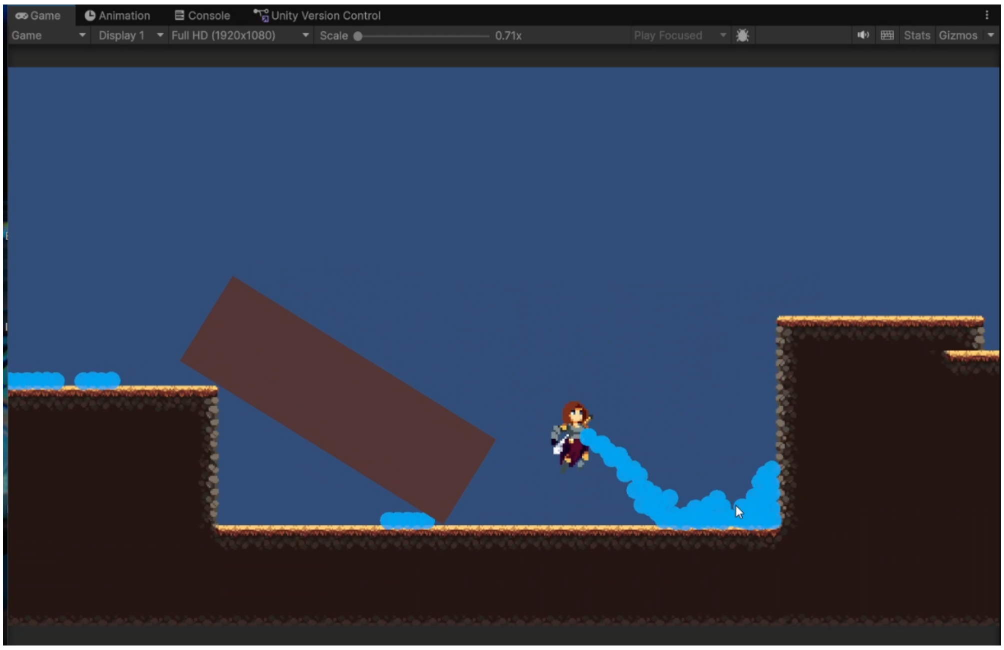

Figure 5.9: Middle-stage traversal test showing Liquid Aether being used.

This test made it easy to understand the relationship between ability implementation and level design. Aether was not only a visual effect or an additional player action. It allowed the player to change specific parts of the environment, such as breaking barriers, moving lightweight objects, activating mechanisms, and opening predefined routes. It helped the project's goal of having level-based puzzles, gates, return paths and meaningful backtracking.

5.4.3 Interface and Environmental Signposting

Only the information required for basic play was presented in order to keep the interface simple. As shown in Figure 5.10, the top-left corner displayed a health bar and a mana bar, while a contextual help panel introduced the primary controls at the beginning of the game. The mana bar indicated the amount of mana available for generating Aether, with different Aether forms consuming different amounts per unit. Mana could be restored through pickups placed throughout the level. Some pickups were positioned in optional or revisited areas in order to provide an additional incentive for exploration.

Figure 5.10: Prototype interface showing health and Aether resource bars, together with an early tutorial panel.

A tutorial panel was placed in the opening area of the prototype. It introduced basic actions including movement, interaction with statues, dialogue choices, attacking, and wall jumping. The panel was intended to provide sufficient information for beginning the prototype without requiring repeated instructional messages throughout the level.

The Aether system was primarily communicated through the visual appearance and behaviour of the generated material. Liquid, Solid, and Gaseous Aether were visually and mechanically distinct, while successful or unsuccessful interactions with environmental objects provided additional feedback. This supported the GameFlow components of control, feedback, and clear goals, since players needed to understand the effect of their input and the resulting state of the interaction[17].

Feedback collected during the later-stage playtesting nevertheless suggested that relying on the generated material alone did not always make the selected Aether form sufficiently explicit. Two participants requested clearer active-form communication: one suggested a clearer ability-switching interface, while another suggested a persistent prompt showing the currently selected form. A future version could therefore include a form icon or dedicated indicator next to the health and mana bars. These responses are discussed further in Section 6, while the limitations of interpreting this feedback from a small exploratory sample are addressed in Section 7.

Environmental signposting was used to communicate possible routes and future interactions through layout, visual contrast, obstacle placement, landmarks, and visible rewards. Blocked objects suggested possible uses for particular Aether forms, while visible but inaccessible objects functioned as potential future goals. These elements used the environment to communicate possible actions and progression opportunities without relying entirely on explicit instructions [8], [13].

5.4.4 Implementation Reflection

The implementation was deliberately limited to the systems required for the research prototype rather than the wider feature set expected in a commercial game. The central technical requirements were connected traversal, Aether-form switching, form-specific environmental interactions, resource feedback, and the ability to reopen predefined routes.

Implementation took place in three main stages. The first established player movement, interaction, combat, and form switching. The second connected the Aether forms to environmental objects and obstacle behaviours. The third integrated these interactions with traversal sequences, interface feedback, environmental signposting, and revisit opportunities.

This staged process produced a playable artefact in which the intended relationships between Aether forms, environmental obstacles, progression conditions, and previously encountered spaces could be evaluated through playtesting and questionnaire responses.

6

Results

6.1 Final Playable Prototype

The final prototype emphasised exploration, traversal, and problem-solving within an interconnected 2D space. The player controls a character who uses a switchable Aether ability system to interact with obstacles and routes. Liquid Aether interacts with lightweight objects and liquid-sensitive mechanisms, Solid Aether breaks designated barriers, and Gas Aether activates vertical devices that provide access to elevated routes.

Together, these interactions formed a gameplay loop designed around reading the level structure and applying the rules associated with each Aether form. Newly acquired forms made previously unavailable routes and interactions accessible in earlier areas. The resulting prototype focused on route variation, readable interactions, and revisiting earlier areas within a limited world structure.

The integrated prototype was used in the first round of playtesting and was subsequently revised in response to participant feedback. The resulting revised build was then used in the second round.

6.2 Playtesting

Two rounds of playtesting were conducted to collect feedback on participants' reported understanding and experience of the prototype. The first round evaluated an initial integrated version of the level and Aether system, while the second round evaluated a revised version produced after addressing feedback on level guidance, interaction communication, and control feel. The complete questionnaire is provided in Appendix A.1, the closed-ended response distributions in Appendix A.2, and the translated open-ended responses in Appendix A.3. The evaluation focused on participants' reported understanding of the Aether forms, their perceptions of route clarity, and whether they described revisiting earlier areas as meaningful rather than repetitive.

6.2.1 Participants' Context and Play Completion

The study involved 14 participants across two rounds of playtesting. The first round involved six participants using an initial integrated version of the prototype, while the second involved eight participants using a revised version developed after feedback from the first round. The revisions between rounds focused primarily on level guidance, interaction communication, movement and control feel, and usability issues reported by first-round participants. Seven participants reported playing for 10–20 minutes, two for less than 10 minutes, three for 20–30 minutes, and two for 30–45 minutes. Five participants completed the full prototype, two completed most of it, one completed approximately the first half, and six experienced only the opening and early sections.

Unless otherwise stated, the questionnaire results presented below combine responses from both playtesting rounds. The identifiers A-P1 to A-P6 refer to participants in the first round, while B-P1 to B-P8 refer to participants in the second round. Because the two rounds used different versions of the prototype, the combined distributions are treated as exploratory descriptive results rather than as direct comparisons between equivalent conditions.

Across the two rounds, 14 participants completed the questionnaire. For Question 1, 7 participants (50%) reported playing for 10–20 minutes, 3 participants (21%) for 20–30 minutes, 2 participants (14%) for less than 10 minutes, and 2 participants (14%) for 30–45 minutes. For Question 2, 5 participants (36%) reported completing the full game, 2 participants (14%) completed most of it, 1 participant (7%) completed approximately the first half, and 6 participants (43%) played only the opening and early sections. The complete distributions are presented in Appendix A.2.

Participants also differed in their familiarity with similar games. In Question 3, 2 participants (14%) reported playing similar games frequently, 9 participants (64%) occasionally, 2 participants (14%) rarely, and 1 participant (7%) almost never. In Question 5, 5 participants (36%) preferred thoroughly exploring optional routes, 4 participants (29%) slightly preferred optional routes, and 5 participants (36%) reported no strong preference. The complete distributions are presented in Appendix A.2, while the titles and genres reported in Question 4 are listed in Appendix A.3.

The playtesting was not intended to determine whether participants had mastered every aspect of the prototype. Instead, it examined how clearly the prototype communicated its goals and interaction rules, and whether returning to earlier spaces felt meaningful rather than repetitive.

The questionnaire responses were therefore treated as exploratory playtesting feedback rather than as evidence of generalisable effects. They were used to examine how participants understood the Aether forms, routes, obstacles, and backtracking structure.

6.2.2 Progression, Route Reading and Ability Understanding

The questionnaire results indicate that participants generally understood the broad objective of the prototype, although route communication was less consistently clear. In Question 6, 9 of the 14 participants (64%) selected “Agree” when asked whether they understood the overall goal of the game, while the remaining 5 participants (36%) selected “Neutral”. No participant selected a negative response. The complete distribution for Question 6 is presented in Appendix A.2.

Responses to Question 8, which asked whether participants could distinguish the main route from optional routes, were more divided. Seven participants (50%) selected “Agree”, six participants (43%) selected “Neutral”, and one participant (7%) selected “Disagree”. The complete distribution for Question 8 is presented in Appendix A.2.

The translated responses to Question 7 provide further context. Twelve of the fourteen participants gave responses that were broadly positive or acceptable regarding progression direction, although several of these responses also included reservations. Participants mentioned missing guidance for reaching high walls, insufficient prompts at the beginning, difficulty noticing an interactable statue, the absence of a map or signposts, and unclear visual communication of unreachable platforms. Two participants described the direction as unclear or not very clear. These responses suggest that the prototype usually communicated a broad direction of progression, but did not consistently communicate how specific routes or interactions should be approached. The complete translated responses to Question 7 are provided in Appendix A.3.

Responses concerning backtracking were more consistently positive. In Question 9, 8 participants (57%) selected “Agree” and 5 participants (36%) selected “Strongly agree” that backtracking felt meaningful rather than simply repeating previously completed paths. One participant (7%) selected “Neutral”, and no participant selected a negative response. The complete distribution for Question 9 is presented in Appendix A.2.

The open-ended responses to Question 10 indicate several reasons why optional and revisited routes were considered worthwhile. Eight participants referred to discovering new areas, scenes, experiences, hidden spaces, or previously unexplored locations. Three responses mentioned faster or more convenient routes. Two referred to obtaining items or upgrades, two referred to gaining clearer information, and one referred to completion as a motivation. Some responses contained more than one reason. Because individual responses could mention more than one reason, these categories are not mutually exclusive. These answers indicate that revisiting was commonly associated with new content, rewards, information, or route advantages rather than only retracing an existing path. The complete translated responses to Question 10 are provided in Appendix A.3.

Understanding of the Aether forms was also rated positively overall. In Question 13, 9 participants (64%) selected “Agree” and 2 participants (14%) selected “Strongly agree" when asked whether they understood the functions of the different Aether forms and could use them appropriately. Two participants (14%) selected "Neutral", while one participant (7%) selected "Disagree". The complete distribution for Question 13 is presented in Appendix A.2.

In Question 14, 8 participants (57%) selected "Agree" and 4 participants (29%) selected "Strongly agree" that the Aether forms created clearly defined experiences in exploration and progression. One participant (7%) selected "Neutral", and one participant (7%) selected "Disagree". Together, 12 of the 14 participants (86%) responded positively to this question. The complete distribution for Question 14 is presented in Appendix A.2.

The responses to Question 18 further illustrate how participants understood the system. Participants referred to switching between forms, opening different routes, interacting with the level, solving puzzles, and experimenting with the physical behaviour of Aether. However, responses to Question 19 also requested clearer tutorials, stronger guidance for individual abilities, and a clearer indication of the currently selected Aether form. The complete translated responses to Questions 18 and 19 are provided in Appendix A.3.

Overall, the results suggest that most participants understood the general functions and distinctions between the Aether forms, while the moment-to-moment communication of the selected form and its possible uses remained less consistent.

6.2.3 Control Feel and Improvement Priorities

Responses concerning movement, jumping, combat, and ability use were less positive than those concerning backtracking and Aether-form understanding. In Question 15, 7 of the 14 participants (50%) selected "Neutral", 3 participants (21%) selected "Agree", 1 participant (7%) selected "Strongly agree", and 3 participants (21%) selected "Disagree". Overall, 4 participants (29%) gave a positive response, while 10 participants (71%) selected either a neutral or negative response. The complete distribution is presented in Appendix A.2.

The responses suggest that participants attributed the issue to different aspects of the experience. In Question 16, 6 participants (43%) selected "Mostly from in-game behaviour", 4 participants (29%) selected "Mostly from the control scheme", 3 participants (21%) selected "From both", and 1 participant (7%) selected "I did not notice any major issue". However, because these factors were not tested independently under controlled conditions, the data cannot determine the precise cause of the reported problems. The complete distribution is presented in Appendix A.2.

Participant responses identified control feel, route guidance, and feedback clarity as the main areas requiring improvement. In Question 19, eight participants referred to movement, jumping, platforming, or general control feel, while five participants requested clearer guidance, tutorials, route direction, or more visible interactable elements. Participants also mentioned missing damage feedback, unclear jump feedback, and rough combat feedback. Because individual responses could mention more than one issue, these categories are not mutually exclusive (Appendix A.3).

Responses to Questions 18 and 20 more frequently identified exploration, the use of different Aether forms, level interactions, and the opening of new routes as strengths, while Question 19 more frequently identified control feel, guidance, and feedback as areas for improvement (Appendix A.3).

7

Interpretation and Limitations

7.1 Interpretation of Findings

7.1.1 Backtracking, Progression Clarity and Route Reading

The prototype was designed so that newly acquired Aether forms could give previously visited areas additional functions. The intended progression structure included branching routes, reconnecting regions, ability-dependent barriers, and optional paths that became available after new forms were acquired. This intended structure is documented in the Game Design Document in Appendix B and described in Section 5.3. However, these materials record the design intention and implementation; they do not by themselves demonstrate how participants experienced the resulting backtracking structure.

The designed progression sequence introduces Liquid Aether in the Flooded Region, Solid Aether in the Sanctuary Nexus, and Gas Aether in Sanctuary Hall. Solid Aether makes designated barriers in the Frostrock Region passable, while Gas Aether enables access to vertical devices and elevated routes. After Gas Aether becomes available, the level structure offers both a direct route toward the boss and an optional route toward the Windworn Region. These are features of the implemented level structure rather than observations of participant behaviour. Because the study did not include gameplay observation, route telemetry, or recorded movement data, it is not possible to determine which routes participants actually selected, how frequently they returned to earlier regions, or whether they followed the intended progression sequence.

The questionnaire responses suggest that the prototype communicated the broad progression goal more clearly than it communicated the distinction between specific main and optional routes. In Question 6, 9 of the 14 participants (64%) selected "Agree" that they understood the overall goal, while 5 participants (36%) selected "Neutral". In Question 8, 7 participants (50%) selected "Agree" that they could distinguish the main route from optional routes, 6 participants (43%) selected "Neutral", and 1 participant (7%) selected "Disagree" (Appendix A.2). Participant responses concerning backtracking were more positive. In Question 9, 8 participants (57%) selected "Agree" and 5 participants (36%) selected "Strongly agree" that backtracking felt meaningful rather than repetitive. One participant (7%) selected "Neutral", and no participant selected a negative response (Appendix A.2).The open-ended responses to Question 10 associated revisiting with new areas, hidden spaces, new experiences, faster or more convenient routes, items, upgrades, additional information, and completion. These responses suggest that participants often understood revisiting as offering new content or route value rather than only requiring repeated movement (Appendix A.3).

The open-ended responses indicate that route communication was not consistently clear. Participants mentioned insufficient prompts, difficulty noticing an interactable statue, unclear guidance for reaching high walls, missing map or signpost support, and unclear visual communication of inaccessible platforms (Appendix A.3). These responses suggest that the broad progression direction was often understandable, while the communication of specific routes and interactions remained less reliable.

The findings do not show how participants' route-reading competence changed over time, because the study did not record their moment-to-moment decisions or learning process. The questionnaire instead provides retrospective self-reports. These reports indicate that many participants understood the broad progression goal, while route guidance, signposting, and the visibility of specific interactions still required refinement. This interpretation is consistent with the mixed responses to Question 8 and the guidance-related comments in Questions 7 and 19 (Appendix A.2; Appendix A.3).

Taken together, the questionnaire responses suggest that participants generally perceived backtracking as meaningful when revisiting provided access to new areas, rewards, information, or route advantages. At the same time, the more mixed responses concerning route distinction indicate that this experience depended on clearer guidance and communication. The findings therefore support a context-specific interpretation: within the tested prototype versions, the combination of newly available interactions and changed route value was associated with positive perceptions of revisiting, but the study does not establish how participants navigated these routes in practice.

7.1.2 Ability Forms, Interaction Readability and Player Learning

Closed-ended questionnaire responses suggest that most participants understood the general functions of the Aether forms. In Question 13, 9 participants (64%) selected "Agree" and 2 participants (14%) selected "Strongly agree" that they understood the functions of the different Aether forms and could use them appropriately. Two participants (14%) selected "Neutral", while 1 participant (7%) selected "Disagree" (Appendix A.2). In Question 14, 8 participants (57%) selected "Agree" and 4 participants (29%) selected "Strongly agree" that the Aether forms created distinct exploration and progression experiences. One participant (7%) selected "Neutral", and 1 participant (7%) selected "Disagree" (Appendix A.2). Liquid, Solid, and Gas Aether were implemented as different forms of one underlying ability rather than as unrelated tools. From an MDA perspective, this design connected distinct interaction rules with the intended experiences of learning, environmental interpretation, and route choice [11]. However, the questionnaire data only show participants' reported understanding of the forms; they do not reveal how their mental models developed during play.

Open-ended questionnaire responses identified several specific communication problems. In Question 19, participants requested clearer tutorials for individual abilities, stronger route guidance, clearer presentation of interactable objects, and a more visible indication of the currently selected Aether form. One participant specifically requested clearer UI feedback for ability switching, while another requested a persistent prompt showing the active form. Other responses suggested placing the form-introduction statues closer together or providing a clearer demonstration of their functions (Appendix A.3). The closed-ended responses to Question 17 were also mixed. Seven participants (50%) selected "Agree" and 2 participants (14%) selected "Strongly agree" that the interaction rules and feedback were clear, while 3 participants (21%) selected "Neutral" and 2 participants (14%) selected "Disagree" (Appendix A.2). Thus, 9 participants (64%) responded positively, while 5 participants (36%) gave a neutral or negative response. Together, these responses suggest that the overall interaction logic was understandable to many participants, but the communication of the active form, ability-specific instructions, and the visibility of some interactable elements remained inconsistent. Because gameplay was not directly observed and interaction failures were not logged, the data cannot determine exactly when these misunderstandings occurred or which specific interactions failed during play. The available data identify communication problems related to active-form visibility, ability-specific guidance, and interactable elements. However, the study did not directly measure how these issues affected individual choices or learning over time.

7.1.3 Synthesis of Findings in Relation to the Research Question

The research question is: *"In what ways can the design of a multi-form ability system in a Metroidvania prototype broaden solutions to interlocked environments while maintaining legible progression and reducing repetitive backtracking?"*. The findings suggest three design mechanisms through which the prototype addressed the research question: form-based reinterpretation of space, consistent environmental interaction rules, and controlled expansion of available routes. These mechanisms are consistent with previous discussions of ability-gated progression and revisiting in Metroidvania games [1], [2].

The first design mechanism was the use of several forms within one Aether system. The prototype was designed so that previously encountered routes and obstacles could gain additional functions after new forms became available. Questionnaire responses to Questions 9 and 10 suggest that many participants perceived revisiting positively when it provided access to new areas, hidden spaces, rewards, information, or more convenient routes (Appendix A.2; Appendix A.3).

The second design mechanism was the use of repeated environmental interaction rules for each Aether form. Question 13 indicates that most participants reported understanding the functions of the forms, while Question 14 indicates that most participants perceived them as creating distinct exploration and progression experiences. However, Question 17 and the open-ended responses to Question 19 show that interaction feedback, active-form communication, and ability-specific guidance were not consistently clear (Appendix A.2; Appendix A.3).

The third design mechanism was the controlled expansion of available routes after new forms were introduced. The prototype offered additional barriers, optional branches, and revisit opportunities as the Aether system developed. Positive responses to Question 9 and the reasons reported in Question 10 provide context-specific support for the interpretation that revisiting was often experienced as more than simple repetition. However, because the study did not include route telemetry or direct gameplay observation, it cannot determine how participants actually navigated these options.

The findings also show that the usefulness of the three design mechanisms depended on clear communication. Participants generally reported understanding the Aether forms and experiencing them as distinct, but route distinction, active-form communication, tutorials, and interaction feedback were less consistently clear. This suggests that adding multiple forms is not sufficient by itself; their relationships to obstacles, routes, and resulting feedback must also be communicated clearly during play.

Within the tested prototype versions, the findings suggest that a multi-form ability system can support varied interpretations of previously visited spaces when each form has a distinct and consistently communicated environmental role. Participants generally reported meaningful backtracking and distinct exploration experiences, while route distinction, interface communication, and interaction feedback were less consistently clear. The study therefore provides context-specific support for this design approach rather than evidence that the same effects would occur in other Metroidvania games or larger implementations.

7.2 Limitations

7.2.1 Prototype Scope and Design Boundaries

The prototype was developed as a small-scale 2D research artefact rather than a full-scale commercial game. This affected the number of Aether forms implemented, the size of the world, and the range of environmental interactions included. The project was deliberately limited in scope to allow the main design enquiry to be answered with a single coherent playable artefact. This is consistent with the Research through Design approach, in which an artefact is used to investigate a specific design problem rather than to function as a completed production system [16].

A small prototype cannot reproduce the full structural complexity of the Metroidvania genre, including large-scale world organisation, layered navigation, long-term progression, and the player's growing familiarity with the environment [1]. The prototype therefore represents one specific implementation of a multi-form, material-based ability system. Its findings should be interpreted in relation to this limited world structure and interaction set rather than as a general model for Metroidvania progression. Some elements of the level structure and interaction logic were simplified to maintain a manageable and testable prototype scope.

7.2.2 Playtesting and Questionnaire Constraints

The results are interpreted as context-specific evidence about how 14 participants experienced the prototype versions used in the two playtesting rounds. They support an assessment of which interaction rules, progression elements, and backtracking opportunities were communicated successfully, and which areas required further refinement. This context-specific assessment remains appropriate within a Research through Design approach, but it does not establish that the same outcomes would occur with other participant groups, larger game worlds, or different implementations of a multi-form ability system [16].

The context of testing also influences the evaluation. The study involved 14 participants across two rounds of playtesting. The first round involved six participants using an initial integrated version of the prototype, while the second involved eight participants using a revised version developed after feedback from the first round. The revisions between rounds focused primarily on level guidance, interaction communication, movement and control feel, and usability issues reported by first-round participants. Seven participants reported playing for 10–20 minutes, two for less than 10 minutes, three for 20–30 minutes, and two for 30–45 minutes. Five participants completed the full prototype, two completed most of it, one completed approximately the first half, and six experienced only the opening and early sections.

This uneven exposure was a consequence of the study design. The questionnaire therefore represents experiences from the opening sections, including movement, control feel, route reading, and early encounters with the Aether system, more strongly than later form-dependent routes and backtracking sequences. Because the second-round version incorporated revisions based on feedback from the first round, the combined questionnaire distributions describe responses collected across two iterative prototype states rather than under equivalent testing conditions. The study was not designed to compare the two rounds statistically, and differences between the prototype versions prevent the responses from being treated as equivalent experimental conditions.

The study relied on retrospective questionnaire responses and did not include direct gameplay observation, route telemetry, interaction logs, or recordings of failed actions. The findings can therefore describe what participants reported, but they cannot determine precisely when interaction problems occurred, how frequently they occurred, or which routes participants selected during play.

8

Conclusion and Further Work

8.1 Conclusion

The purpose of this thesis was to examine the following research question: *In what ways can the design of a multi-form ability system in a Metroidvania prototype broaden solutions to interlocked environments while maintaining legible progression and reducing repetitive backtracking?*. To address this question, the project designed a small-scale 2D prototype with three Aether forms, liquid, solid and gas, which served as a research artefact to be reflected on in design and played with. The project also created a supplemental design and implementation document describing the structure of the ability system, layout of levels, and important implementation decisions.

The project demonstrates that a multi-form ability system can be used to help make backtracking meaningful when revisiting earlier spaces affects the player's decisions as well. In the prototype, new Aether forms were not just able to unlock new ways. Rather, they altered the way previous spaces were utilized, pathways led to be read, and obstacles could be approached. This could be seen in the overall structure of the level as later areas re-connected to earlier areas and made old areas valuable again by new paths, optional rewards, and through new use of familiar mechanics. For this reason, the term "backtracking" came to be understood as a "reinterpretation" of the same environment by way of greater skill and knowledge.

The project also demonstrates that this design method is only effective if there is a clear progression of the learning. The width and length of the solution space does not necessarily make for a better experience. It's only useful if players can figure out how the form, obstacle and route go together. This is assumed to rely on a clear learning sequence, readable environmental cues, rules for interactions are set and consistent throughout, and a level structure that differentiates the main route from optional routes while still maintaining the need to explore. At these points where they are well understood, the multi-form system allows for variation in the route and for meaningful revisiting. These are spaces where they are less tangible, where the same design can cause hesitation or confusion.

Thus, the answer to the research question is yes, but only under certain conditions. The study shows that a multi-form ability system can give players more ways to move through an interlocked Metroidvania-style prototype and can reduce repetitive backtracking to some extent. In this prototype, the effect came from the way new Aether forms changed the value of earlier spaces. When players returned to previous areas, they were not only repeating the same movement. They were using liquid, solid, and gaseous Aether to understand barriers, routes, and goals in new ways. Because these forms were different states of one core ability, earlier spaces could offer new paths, new uses, and new rewards. This made revisiting feel more like replanning than simple repetition.

The study also reveals that this type of design is only successful when each form should have an understandable function, so that players know what the function of each form is. The relationships between obstacles and abilities need to be consistent with respect to the ability to develop reasonable expectations from past experiences. The layout, landmarks, visual contrasts and rewards placement should also provide clarity of progression in the level, allowing players to identify the primary path, secondary paths and spaces to revisit. In the absence of these, a multi-form ability system can lead to a more complex system, but can they make the progression and backtracking experience better for the player?

The novelty of this thesis is to demonstrate through a playable prototype how the combination of ability structure, route structure and environmental guidance can contribute to a more meaningful experience of going backward. This project views backtracking as a new type of decision making, with revised goals, alternative route options and more avenues for interaction.

8.2 Further Work

This study can be further extended in three directions. The first is to grow the prototype itself. A small and connected installation is used to investigate the connection between the Aether forms, the variation in route, and meaningful backtracking in the current project. A larger/prototyped would have more regions, longer revisit chains, and more complex mixes of liquid, solid, and gaseous Aether. With this it would be possible to see if the same design principle would work when the world gets bigger and there are more layers of choice available. It would also enable the project to pursue additional possibilities, different rewards, and more scenarios where players had to use a combination of forms instead of one form at a time.

The second direction is to develop a more systematic evaluation process. Current playtest materials and questionnaires provide some insight into player reaction to the prototype, but primarily are based on initial impression and early stage experience rather than a fully structured evaluation. Further research may feature a larger sample size, more diversity among the players, and better comparisons between players of varying experience in the genre Metroidvania. Comparing multiple iterations of the prototype or different level variants would also be useful to be able to see which changes lead to increased clarity of progression, route reading and form understanding.

The third approach is to push the design question further. This thesis concentrated on the one ability system in one small scale Metroidvania prototype. Further studies may be undertaken to compare this model with other progression models, such as multiple different abilities rather than a single transformable ability, or more tightly gated structures than interlocked route networks. This would help identify which features in the current design help to make it meaningful for learners to backtrack, and which features are more prototype-specific. This can then be expanded upon not only as a larger game prototype, but also a more comprehensive exploration of the interaction between ability structure and progression/exploration in interconnected games.

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A

Playtesting Questionnaire and Response Data

This appendix contains the questionnaire used during playtesting and the collected response data. The responses were originally collected in Chinese and translated into English for this thesis. The data is organised in a compact form to avoid repeating the full questionnaire for every participant. Closed-ended questions are presented as response distributions, while open-ended questions are listed as translated individual responses. The participant identifiers A-P1 to A-P6 and B-P1 to B-P8 refer to the two uploaded response files.

A.1 Questionnaire Questions

1. How long do you think you spent playing the game?
2. Did you complete the game?
3. Have you played similar games before?
4. What games, genres, or similar titles have you played before?
5. In games like this, which playstyle do you usually prefer?
6. Were you able to understand the game's overall goal?
7. Did the direction of progression feel clear to you? Why or why not?
8. Could you clearly distinguish the main route from optional routes?
9. Did backtracking feel meaningful rather than simply repeating previously completed paths?
10. If optional routes felt worth trying, what were your main reasons for doing them?
11. Did different areas feel like they required different experience levels from the player?
12. Please describe your impressions of each area, and explain what kind of experience level or difficulty you think each one should have.

13. Were you able to understand the functions of different Aether forms and use them appropriately in the levels?
14. Did the Aether forms create clearly defined experiences in exploration and progression?
15. Did the feel of movement, jumping, combat, and abilities feel natural?
16. In your answer to the previous question, where did the source of that feeling mainly come from?
17. Did the game's interaction rules and feedback feel consistent and easy to understand?
18. What did you think was the most interesting part of the game, and why?
19. What do you think needs to be improved the most, and why?
20. If you could keep only one most outstanding strength of the game, what would it be?

A.2 Closed-ended Response Summary

No.	Question	Response distribution
1	How long do you think you spent playing the game?	10–20 minutes: 7 (50%); Less than 10 minutes: 2 (14%); 20–30 minutes: 3 (21%); 30–45 minutes: 2 (14%)
2	Did you complete the game?	I only played the opening and early sections: 6 (43%); Yes, I completed the full game: 5 (36%); I completed most of the game: 2 (14%); I only completed the first half: 1 (7%)
3	Have you played similar games before?	Occasionally: 9 (64%); Almost never: 1 (7%); Frequently: 2 (14%); Rarely: 2 (14%)
5	In games like this, which playstyle do you usually prefer?	No strong preference / both are acceptable: 5 (36%); Slightly prefer exploring optional routes: 4 (29%); Prefer exploring optional routes and searching thoroughly: 5 (36%)
6	Were you able to understand the game's overall goal?	Agree: 9 (64%); Neutral: 5 (36%)
8	Could you clearly distinguish the main route from optional routes?	Agree: 7 (50%); Neutral: 6 (43%); Disagree: 1 (7%)
9	Did backtracking feel meaningful rather than simply repeating previously completed paths?	Agree: 8 (57%); Neutral: 1 (7%); Strongly agree: 5 (36%)
11	Did different areas feel like they required different experience levels from the player?	Agree: 9 (64%); Neutral: 3 (21%); Strongly agree: 2 (14%)

No.	Question	Response distribution
13	Were you able to understand the functions of different Aether forms and use them appropriately in the levels?	Neutral: 2 (14%); Disagree: 1 (7%); Agree: 9 (64%); Strongly agree: 2 (14%)
14	Did the Aether forms create clearly defined experiences in exploration and progression?	Agree: 8 (57%); Disagree: 1 (7%); Neutral: 1 (7%); Strongly agree: 4 (29%)
15	Did the feel of movement, jumping, combat, and abilities feel natural?	Neutral: 7 (50%); Agree: 3 (21%); Disagree: 3 (21%); Strongly agree: 1 (7%)
16	In your answer to the previous question, where did the source of that feeling mainly come from?	Mostly from in-game behaviour: 6 (43%); From both: 3 (21%); Mostly from the control scheme: 4 (29%); I did not notice any major issue: 1 (7%)
17	Did the game's interaction rules and feedback feel consistent and easy to understand?	Agree: 7 (50%); Neutral: 3 (21%); Disagree: 2 (14%); Strongly agree: 2 (14%)

A.3 Open-ended Translated Responses

The following tables list the translated individual answers for open-ended questions.

Question 4: What games, genres, or similar titles have you played before?

Participant	Translated response
A-P1	Dead Cells
A-P2	I rarely play side-scrolling platform games
A-P3	Hollow Knight
A-P4	Hollow Knight
A-P5	ICEY and Alice in Cradle
A-P6	ENDER LILIES series, Ori series, Hollow Knight series, and Celeste
B-P1	Castlevania
B-P2	Record of Lodoss War: Deedlit in Wonder Labyrinth, Touhou Luna Nights, and Salt and Sanctuary
B-P3	Hollow Knight and Metroid
B-P4	Silksong and Ori
B-P5	Blasphemous and MapleStory
B-P6	Neon Abyss
B-P7	Detective puzzle games, action adventure, role-playing games, and card games
B-P8	Hollow Knight

Question 7: Did the direction of progression feel clear to you? Why or why not?

Participant	Translated response
A-P1	Clear, but some guidance was missing, such as how to get over high walls.
A-P2	Generally clear.
A-P3	Clear

Participant	Translated response
A-P4	Not clear. I only knew to move from left to right.
A-P5	Not very clear. There were too few prompts at the start, which delayed me for a while. I usually test all controls in place and did not notice that the nearby statue was interactive. Gradual control teaching during progression was good, but I still suggest adding a more complete control explanation in the menu, otherwise players may get stuck somewhere.
A-P6	Clear, because there was basically only one route before the point where I got stuck.
B-P1	Very clear
B-P2	Relatively clear. The game gave a fairly obvious sense of direction.
B-P3	Relatively clear. I tended to move toward statues and refill points.
B-P4	Mostly clear, but I understood the main direction only after exploring the map overall.
B-P5	It was acceptable, but a map or signposts were missing.
B-P6	Clear
B-P7	Clear, but if stone steps cannot be jumped onto, the spacing could be made higher so it is visually obvious that the player cannot reach them.
B-P8	Yes. The statues and rewards helped me understand the general direction.

Question 10: If optional routes felt worth trying, what were your main reasons for doing them?

Participant	Translated response
A-P1	Clearer information.
A-P2	New areas bring new experiences.
A-P3	New areas.
A-P4	New experiences.
A-P5	Convenient routes, new scenes, new NPCs, and story content.
A-P6	Hidden areas, side quests that may even affect the ending, and faster routes.
B-P1	There were upgrade items.
B-P2	Clearer information.
B-P3	There were items I needed.
B-P4	I like full completion. If the game has a built-in collection percentage system, reaching 100 percent completion would make me happy.
B-P5	A change of pace that avoids boredom.
B-P6	New areas or faster speedrun routes.
B-P7	I had not been there before and was curious about what was there.
B-P8	New experiences.

Question 12: Please describe your impressions of each area, and explain what kind of experience level or difficulty you think each one should have.

Participant	Translated response
A-P1	The area before the elevator is suitable for beginners.
A-P2	As a less skilled player, I felt that the moving platform area and the boss were the easiest parts. Other areas involving jumping and mechanics were more difficult both to understand and to control.
A-P3	It was hard to distinguish them
A-P4	I did not have a strong impression.
A-P5	The underground areas generally felt less like the main route. They seemed more difficult, required more control skill, and created some pressure for the player.
A-P6	Sorry, my experience was too limited, so I do not have much to say yet.
B-P1	Each area corresponds to a different ability.

Participant	Translated response
B-P2	The first downward area near the first statue seems designed for beginners, but the actual control feel was not very beginner-friendly. The area to the right of Area 1 felt like a side route or shortcut, requiring the Aether form that can break stones. The downward Area 2 from Area 1 felt like the main route, where the player gains the stone-breaking Aether and needs to switch Aether forms to activate the downward switch. The downward Area 3 from Area 2 also felt like the main route. After gaining the Aether that can lift platforms, going right and using Aether to activate the switch seemed to trigger a boss fight. Returning from Area 3 to Area 2, then going left to Area 4 or down to Area 5, felt more like side routes. These required careful jumping, otherwise it was easy to miss the place where the switch could be triggered. In Area 5, the player could obtain something that seemed to increase attack power, then return to Area 3 and begin the boss fight.
B-P3	After gaining the breaking ability, I thought of the right-side area I had not visited before, so I returned to use that ability and entered the boss room.
B-P4	Most of the map felt like a dungeon. Different areas used different particle forms, and the interaction between each form and the map worked well. The design where gaseous particles interact with platforms to make them float felt novel.
B-P5	The lava area feels like a side route.
B-P6	I did not have enough skill to explore all areas, and the opening beginner area felt difficult.
B-P7	I cannot describe it clearly, because the differences were not very obvious.
B-P8	The area before encountering the large enemy is suitable for beginners. There are small enemies for practice, and it helps players understand the different Aether functions and become familiar with the controls.

Question 18: What did you think was the most interesting part of the game, and why?

Participant	Translated response
A-P1	Breaking walls with the right mouse button.
A-P2	The most interesting part was freely exploring the uses of different abilities and thinking about how to complete the game, because discovering a solution felt rewarding.
A-P3	None
A-P4	The 2D pixel Metroidvania style.
A-P5	Exploring the uses of different skills felt novel and had a lot of exploratory space. However, the tutorial was not clear enough, and some uses that I could imagine were not available in the game.
A-P6	Aether has collision volume, which feels like it could create many interesting possibilities in map exploration.
B-P1	The exploration sections
B-P2	Using different Aether forms to explore different areas was interesting, although I cannot explain exactly why.
B-P3	The simple puzzles based on switching abilities.
B-P4	Switching between the three Aether particle forms and interacting with the map.
B-P5	Exploration
B-P6	Exploration and puzzle-solving
B-P7	Solid Aether can launch the player when released, which makes the physics engine feel interesting. Liquid Aether can bounce the player, almost like a bubble bath, and cannot block spikes, which was also fun. For gaseous Aether, although I did not know why it could make both the platform and the player fly, the idea that insufficient gaseous Aether limits flight distance was also interesting.
B-P8	Different Aether forms have their own interactions, and different Aether forms can be used to open different paths.

Question 19: What do you think needs to be improved the most, and why?

Participant	Translated response
A-P1	Mana did not recover automatically when it ran out, and there was no feedback when hit by enemies.
A-P2	Guidance for different abilities, more gradual difficulty in level design, and clearer display of interactable elements in the scene, perhaps with more obvious colour differences.
A-P3	Control feel, especially the wall-jump system.
A-P4	Control feel. The jump always seemed to follow one fixed angle.
A-P5	Character control continuity, map layout, and control/gameplay tutorials. Personally, I felt that too many high walls created pressure and were not suitable for the beginning.
A-P6	Platforming feel, mainly wall climbing, wall jumping, and dashing. It may be worth trying a ledge-climbing design. Also, the Aether switching and blocking inputs may overlap.
B-P1	Insufficient guidance.
B-P2	Overall control feel and guidance. These affected the overall game flow.
B-P3	The wall-jump feel was a little strange and triggered too easily. It would be helpful to add a simple UI display for ability switching.
B-P4	Jump feedback was poor when the character was at the edge of a step. It felt as if the falling animation had higher priority than the jumping action, so when I tried to jump upward, the character often fell downward in that direction instead.
B-P5	Jump feel. When standing close to a wall, the character automatically stuck to it and jumped in the opposite direction.
B-P6	Combat feedback. The hit sound effects or animations felt rough.
B-P7	I hope the three statues can be placed together as beginner guidance, with a small demo level before the main exploration so players can become familiar with the three abilities. If these abilities are important for puzzle-solving, they should not be separated too much before players understand them.
B-P8	There should be a prompt for the current Aether form, otherwise it is sometimes easy to forget which form is active.

Question 20: If you could keep only one most outstanding strength of the game, what would it be?

Participant	Translated response
A-P1	The character does not immediately fall to death when attached to a wall. I suggest adding other movement options while sliding down.
A-P2	Puzzle-solving through combinations of the three different abilities.
A-P3	Art style
A-P4	Art style
A-P5	The design and use of the three elements.
A-P6	The Aether design
B-P1	The interactions worked quite well.
B-P2	Using and combining different Aether forms to explore different areas.
B-P3	Returning to earlier areas after gaining new abilities to open blocked paths.
B-P4	The map interactions created by the three Aether particle states. I hope this system can also be used in boss fights.
B-P5	The particle/Aether gameplay
B-P6	The use of the three Aether forms
B-P7	Interesting uses of Aether and the Aether engine.
B-P8	The different Aether forms having different functions

B

Game Design Document

This appendix contains the game design document used during the development of the prototype. The document includes the project description, gameplay structure, Aether ability system, level design, progression logic, and technical description.

Underisle

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1. Project Description

This project is a small-scale 2D Metroidvania-style prototype set in an interconnected world. It is built around a multi-form, switchable ability system. As new forms become available, players gain additional ways to navigate spaces, uncover new routes, and engage with the world from different perspectives. The project aims to make backtracking a more varied and meaningful part of progression while maintaining a clear and coherent overall structure.

2. Project design

2.1 Game story, theme, story progression

Story

The player explores downward from the surface of a floating island suspended above a sea of clouds. As the journey continues, new forms of Aether gradually become available, eventually leading the player to a forgotten ancient sanctuary buried deep within the island.

Theme

The game centers on exploration and rediscovery. As the player progresses, previously visited areas reveal new paths and new meaning through changes in ability. This theme is expressed not only through the descent itself, but also through the player’s repeated reinterpretation of the same spaces over time.

Story Progression

The game begins at the surface of the floating island. This opening section establishes the basic controls, the first combat encounters, and the player’s initial objective, while guiding the player into the island’s interior. From there, the player gradually moves through a series of distinct regions and gains new forms of Aether along the way. As these abilities expand, earlier areas open up through new entrances, shortcuts, and connecting routes. Eventually, the player passes through the island’s interconnected inner spaces, reaches the sanctuary at its deepest point, and brings the journey to its conclusion in the core area.

2.2 Gameplay

Goals

Overall: The goal of the game is to use three-state Aether abilities to explore and navigate a Castlevania-style level and ultimately escape the area.

Gameplay: The specific gameplay varies depending on the level: for example, some levels require building bridges using ice blocks, while others require using Aether currents to push objects out of the way. These levels will challenge players' abilities flexibly—either individually or in combination—to solve a series of small puzzles.

Game Mechanics

The game's core mechanics are built around a switchable three-state Aether system. Players use Aether in liquid, solid, and gas forms to navigate space and interact with the environment in different ways. These forms are not treated as separate tools, but as different expressions of the same core ability, allowing players to approach obstacles and situations through a shared mechanical logic. Liquid form emphasizes flow and movement, solid form emphasizes stability and physical support, and gas form emphasizes upward movement and dispersal. Together with movement, interaction, and combat, this system forms the basis of traversal, problem solving, and moment-to-moment play.

Core Gameplay

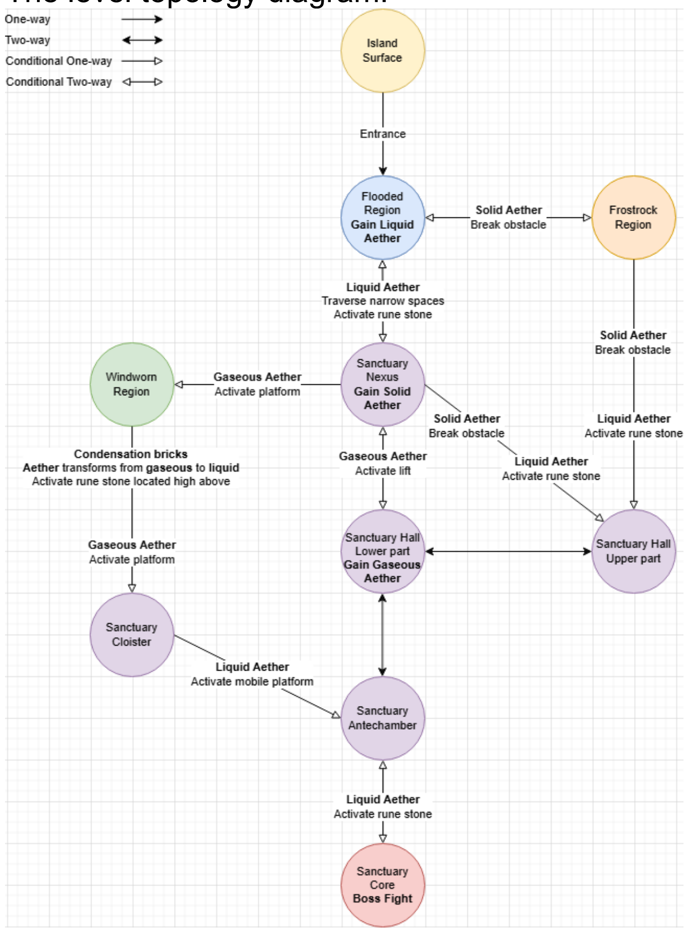
1. **Core Functions**
   a) Core player functions include movement, jumping, combat, contextual interaction, ability use, and form switching during play.
   b) The game uses mouse-and-keyboard controls.
   c) Basic interface elements provide essential gameplay feedback during play.
   d) Menu and pause functions support starting, suspending, and resuming play.
2. **World Structure**
   a) The game is structured as one large, interconnected level composed of multiple linked regions.
   b) These regions branch, reconnect, and loop back into earlier spaces.
   c) Returning to previous areas is part of the world structure itself rather than a separate layer outside normal progression.

   d) The overall layout supports exploration and route choice while keeping the broader direction of play readable.

3. **Progression Logic**
   a) Progression is shaped by the gradual expansion of player options rather than a single fixed forward path.
   b) As additional forms become available, earlier spaces gain new value through new routes, new uses, and new ways forward.
   c) Later regions remain tied to the same broader world, so new possibilities extend the existing structure instead of replacing it.
   d) Backtracking creates new decisions and opportunities rather than repeating the same solved actions.
   e) The progression structure supports multiple approaches while maintaining overall clarity.

4. **Level Design**
   a) Level design is built around route choice, spatial readability, and meaningful variation in player approach.
   b) Different routes may vary in execution difficulty, complexity, clarity, and time cost, allowing different player tendencies to find viable ways forward.
   c) New mechanics and form-based interactions are introduced through a learning curve that moves from introduction to practice, variation, and later combination.
   d) Guidance is embedded in layout, landmarks, contrast, and spatial composition so that players can notice possibilities through the environment.
   e) Environmental rules and visual cues remain consistent, allowing players to make reasonable predictions based on what they have already learned.

f) The level topology diagram:



5. **Combat and Interaction**

   a) Combat is integrated into exploration and progression rather than treated as a separate activity.

   b) Enemy encounters contribute to pacing and variation across different parts of the world.

   c) Environmental interaction supports traversal and progression across connected spaces.

   d) Non-player characters and dialogue are used where needed to provide context or reinforce progression.

   e) Major combat or boss encounters serve as key peaks within the overall gameplay flow.

Progression and challenge

Progression is shaped by the gradual expansion of player options within an interconnected world. As new forms become available, players gain new ways to move through spaces, access routes, and continue forward through previously visited and newly reached areas. This structure is intended to make backtracking a meaningful part of progression by turning return journeys into opportunities for new decisions rather than repeated movement.

Challenge develops through the increasing complexity of spaces and the growing range of actions available to the player. Early sections introduce the basic logic of movement and form use in clear and controlled situations. Later areas place greater emphasis on route judgment, timing, and the effective combination of available forms. The difficulty comes less from punishment and more from asking players to recognize, compare, and make use of a wider range of possibilities while keeping overall progression clear.

Game feature

The project combines Metroidvania-style progression with physics-based environmental interaction. Instead of relying only on fixed gates such as keys, doors, or single-purpose unlocks, it uses a multi-form ability system to create different ways of moving through spaces and responding to obstacles. This allows progression to be shaped not only by access, but also by how players interpret and use the same space over time.

2.3. Art design

Art style

Pixel art style is used in the project. Many Castlevania games choose this style because pixel art is more accessible for smaller teams compared to other art styles. Additionally, the pixel-based rendering creates a unique, retro aesthetic for players while also simplifying physics calculations for the game system.

Music and Sounds

To complement the art style, 8-bit retro sound effects are used in the music system to create an arcade-like gaming experience for players. These sound effects preserve the project's retro feel, and also help players who love this style stay fully immersed in the game.

3. Technical description

The project will be developed primarily in Unity as a small-scale 2D prototype. Unity serves as the main engine for implementing player movement, ability switching, level construction, environmental interactions, and iterative playtesting throughout development.