

I-Ulysses: A Technical Report

Abstract

The I-Ulysses: Poetry in Motion project is as a virtual reality experience, guiding the user through the unfolding events of James Joyce's *Ulysses* in real-time. Currently there is a lack of research looking at adapting literature into virtual reality, for the purposes of cultural heritage, or for serious learning. I-Ulysses is aimed at addressing this gap, by providing an educational tool, intended to help the user understand key aspects of the book. What follows is a technical report, outlining the objectives, aims and results of the I-Ulysses: Poetry in Motion project.

Keywords— Cultural Heritage, Serious Learning, Virtual Reality

1. Introduction

The I-Ulysses: Poetry in Motion project is focused on cultural heritage, virtual reality and serious learning. James Joyces Ulysses is a novel that uses spatial and auditory metaphors and a real-time adaptation of the novel thus has intriguing potential. Currently, there is a lack of projects that have created real-time adaptations of fiction. The following paper will look at the value of game development media to that end and for potential use for cultural heritage. The authors' research has referenced the concepts of Anne Derryberry, Katie Salen and Erich Zimmerman: meaningful play and serious learning in games; J.M. Dondlingers work on virtual learning environments, Ellis work on educational game design and Donald Norman's *The Design of Everyday Things* (3, 24, 6, 10, 17).

The I-Ulysses project has adapted James Joyce's novel *Ulysses* into a spatial environment. Here the spatial and auditory aspects of the environment are connected to specific audio-spatial events from the book, following the method of employing sound cues as employed by Joyce in *Ulysses*. The research was undertaken as part of the Digital Arts Humanities program between 2011 and 2015. An industrial/academic placement also took place in the third year, with the Computer Graphics Department (GV-2) at Trinity College Dublin, with Professor John Dingliana. During this placement, the author was given access to assets in OGRE from the Inside Joycean Dublin Project, a sister-project, and was tasked with gamifying them. It should be stated that the project was involved in a commercialization spinout fast track (CFTD-1), with Enterprise Ireland's Kevin Burke, in the third year and that the Inagh Valley Trust was

also involved in this. The I-Ulysses Project was created with the *Unity* engine and the reasons for the choice of Unity will be discussed in the Itinerary section. In the Methods section an overview will be given of the research area, whilst in Structure and Relationship with Ulysses the adaptation-aspect of the project will be noted, in regards to the book; in Cross-section a segment of the finished game is outlined and discussed.

The objectives of this research are:

A) To help users understand the narrative and storytelling techniques of a classic literary work, in a 3-D games format.

B) To facilitate this understanding, in an integrated, multi-modal manner that reflects key aspects of the specific novel's structure.

C) To be able a user to consult contextual information about a book in a real-time context on a mobile platform, whilst walking around the environment it takes place in.

D) To create an interplay between the themes of a book, the historical and physical environment it takes place in and the current environment that the user inhabits.

2. Methods

Game development media is notably different from visual media in a number of important respects, namely in the regard that it uses a combination of previously available graphical techniques to create a directly realistic sense of space and 3-D perspective. Through the use of game development media, the use of sound effects and realistic isometric lighting, games can create a more perceptually realistic experience than a video or cinematic representation of the same space (13, 1). It follows that a user who sees the representation of the more perceptually realistic environment, with sound effects, is more meaningfully immersed in the experience of the environment and potentially the cultural world of a book like *Ulysses* (21), which itself explored a rich aural and acoustic landscape.

This means that a virtual environment can be a useful educational tool because it directly engages the user in the experience of the content they are learning about, especially if it has a spatial dimension. Salen and Zimmerman in the book *Rules of Play: Game Design Fundamentals* derive a list of considerations for what constitutes a game narrative. It is useful in the context of the environments scenarios to address each of these points, referring directly to the I-Ulysses project: "when we frame the space of possibility as a narrative space, a special set of questions arise: where do narratives in a game reside? How can one design games as narrative experience? What kinds of narrative experiences do games make possible? What is the role of narrative in meaningful play (24)?"

Salen and Zimmerman define meaningful play as, what occurs when the relationships between actions and outcomes in a game are both discernible and integrated into the larger context of the game. Salen notes that the design and function of an effective educational game follows the same principle, good educational games will consider the learning goals, content and game play at the same time (ibid).”

The I-Ulysses projects use of a progressive-waypoint system with Unity, a common technique in game development, and the use of an open-world graphical technique compels the user to observe how specific objectives in the environment map onto the themes of Ulysses, creating an experience of meaningful play. Salen and Zimmerman conclude that the use of games as meaningful learning tools can benefit both the game industry, cultural heritage and engineering. J.M. Dondlinger in his report 'Educational Game Design' notes that, educational video games require strategizing, hypothesis testing, or problem-solving; usually with higher order thinking rather than just memorization (6).” A central objective of the I-Ulysses project is to show how a user is provided with an involved experience of the book. The experience is framed in a setting designed to be immersive and that requires a higher-order engagement with the Waypoint system to progress.

The environment adds dimensions of interactivity whereby a user can focus on specific events and then receives further information dependent on their real-time decision-making. These audio-spatial events become nodes or juncture points of meaning, where users can make decisions that affect the environment and their path through it. The project joins theories of spatial and virtual montage, with the theories of hypertext (14) and the concepts relevance for Ulysses. The environment embeds hypertextual elements of Ulysses into this real-time framework of audio-spatial nodes, mirroring the books structure and creating an interactive learning waypoint experience.

The interactive and audio-spatial features of the project mesh together and the objective of this meshing is to provide a serious or meaningful learning experience. The manner by which the qualitative value of the environment is assessed is through use of a rigorous research and testing methodology, precedents for which are found in serious learning game studies (6). The fundamental learning mechanics of game design engages with the real-time principles of interaction, physics, cause, effect and goal-orientation, which, underlies the player-participation aspect of games (10).” This technique is employed to focus the player’s attentions as well as giving them a goal, a sense of having some permanent impact on the objects and the space of the physical environment. Game events are precipitated by the player’s actions producing the psychological perception of a particular interaction event, depending on its context and enforcing this relationship in the player’s mind (ibid).

Perception is an important aspect when considering user-driven applications and can form the crux of virtual environments and the interactions therein. An example can be seen from the Metropolis project (20) that features a similar urban-based environment to I-Ulysses, albeit with a focus towards simulating perceptually plausible crowds. It is noted in the design of metropolis that vari-

ous elements were analysed with respect to perception through the application of psychophysics. This included scene context and camera viewpoints, with findings highlighting the importance of these types of considerations when attempting to create assets that are plausible to viewers. This is further supported through research by O'Connor et al. (18, 19), in which the analysis of perception is focused towards emergent crowd behaviour. In these studies it was identified that perception can hold sway on realism and immersion, in particular within interactive mediums such as games, both for entertainment and serious purposes including education. This proves a fundamental concept for I-Ulysses with its interactive and audio-spatial features, and is further supported through the work of Chan et al. (2) investigating perception of sound within virtual environments. Findings suggest that sound has a significant influence in the design of realistic virtual environments and implications for information gathering when considering crossmodal influences in spatial attention.

This is crucial for I-Ulysses and builds in to game theory as a process of intrinsic reinforcement and provides a learning mechanism that underlies the potential use of games as learning tools (16, 17). In the project, thus, the focus is on using sound and space to encourage the user to learn about the book employing audio-spatial cues, or what might alternately be called cross-sections of each character's daily experience. The interactive features provided by the learning environment aim to produce an experience of what Salen and Zimmerman describe as meaningful play, as was noted before. Anne Derryberry, as part of the report 'Serious Games: Online Games for Learning' concludes that when game design, focuses on learning outcomes, whilst preserving playfulness, serious learning is possible (3). The I-Ulysses environment emulates serious learning through enforcing the connection in the users mind between sound, space and holding specific moments in sharp relief against the bigger picture of the unfolding narrative of Ulysses. This is what Ulysses' cross-sections of human experience are mapped into in the project, an example of which will be detailed below, in the section: Cross-Section.

The methodology for testing the environment relies on several models and educational theories. Randy Garrison's Community of Inquiry model, the blended learning methodology and the Conjecture Mapping methodology of Sandoval, McKenny and Reeves will be discussed momentarily (7, 8, 9, 16, 22, 23). The project uses specific testing scenarios developed by Garrison in Blended Learning in Higher Education: Framework, Principles, and Guidelines (7) and E-Learning in the 21st Century: A Framework for Research and Practice (9) and the Conjecture Mapping models of Sandoval, McKenny and Reeves (22, 23). The scenarios, the conjecture maps, through to the testing procedure and results are committed in the projects testing phases, which will be outlined later on in the paper. The blended learning model applies traditional teaching methods to virtual learning scenarios. Garrison's Community of Inquiry model outlines a diagram, with respective areas of intersection and overlap between the territories of traditional teaching methods and the application of New Media tools; Sandoval, McKenny and Reeves Conjecture Mapping methodology outlines a planning approach to employing design-oriented tools in educational contexts.

In many respects Garrison, Sandoval, McKenny and Reeves work can be read analogously to Svenson, McCarty and Kirshenbaums discussions of Digital Humanities and its prospective engagement with New Media, in the wider body of Literature on the Digital Humanities; which the author researched extensively in preparing the submission of the I-Ulysses PhD thesis (11, 14, 15, 16, 25, 26, 27).

3. Structure and Relationship with Ulysses

Each of the objectives in the I-Ulysses game environment follows a multi-linear story pattern. There are several bonus characters or stories that vary throughout the environment depending on users choices (Bloom, Kernan, Blazes Boylan, The Secretary etc.). These characters stories can be accessed as bonus missions upon completing the final level, which takes place in the Martello Tower. The Martello Tower is like the central hub of the game; the means by which the other sections of the story are connected together and can be accessed from any direction in the level structure, so-to-speak. It should be noted that the story of the game is based on the Wandering Rocks chapter of the book, but it interlinks events that take place throughout its story. Each back-story, or bonus level, comes with text taken from the relevant chapter. This presence may be an image, a sound or something that Joyce directly hints at in the text.

In addition to the directional prompts, this incentivizes the user to pursue specific goals, but does not lock them into certain choices. The environment switches from the city to back stories in the Tower, Kildare and The Chapel and then switches back again to the relevant Wandering Rocks section in the city. The daydreaming quality of each characters thoughts in the book is represented by the user character being able to float around the scene in an unrestricted first-person perspective, rather than the more confined space of the city. When the user clicks on the text menu they are returned to the wider environment (which has been changed by their interaction in the back-story level) and is encouraged to look for other interaction events, which again reveal further dimensions of the story. In the flow chart below one set of connections and interaction outcomes, and the paths needed to unlock them, is represented (see Fig 1).

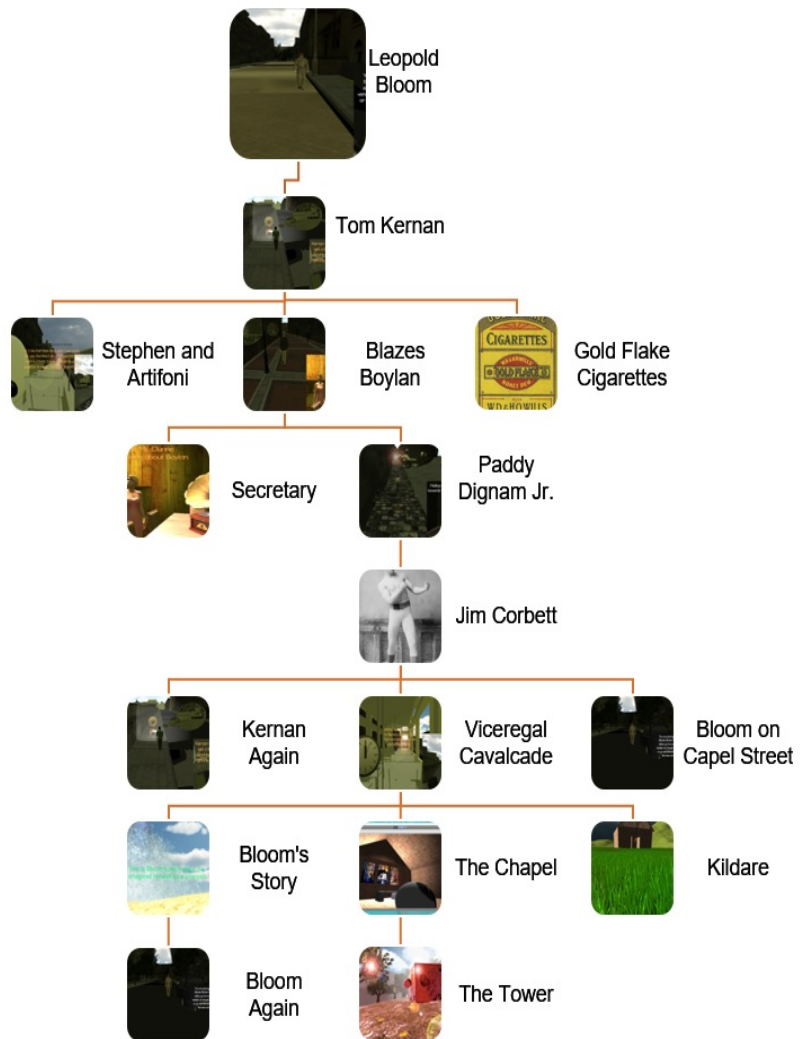


Fig 1. Nodes of the Story

The following sections will demonstrate how the interactive elements of the I-Ulysses environment work. In the second-last section a brief overview of the environment and an itinerary of the elements involved in the running process were provided so as to better contextualize how these elements provide an enhanced sense of interactivity for the user. The specifics of what interactivity means will be discussed here, in the context of designing a learning environment scenario for the user. The section will show how this engages the user and encourages serious learning through the use of game development media. As part of this section, the specifics of how this interactivity meshes together with the interactive technological features explored in I-Ulysses will be further developed. In the Itinerary section, a short technical account will be given of the environment's construction in Unity.

The interactive elements of the environment help to provide a new means of understanding Ulysses. In the environment certain events, such as the back-stories and thought bubbles, will appear at different times, depending on the choice of objectives that each character attempts to complete. This is illustrated with the time-keeping function of the clock, used to suggest that certain assets or Prefabs (a Unity convention, discussed in the Itinerary) in the running environment can alter depending on user choices. In the city-version of the environment the camera also changes its depth of field and moves closer or further away from the user depending on which character they are using, indicating that several different points of view on the environment are possible simultaneously. The thought bubble enables the user to see what the character is thinking based on the objectives and back stories which they have completed. The alternate view port is a view that appears in the bottom right hand corner of the screen can also show other characters paths. These features more fully realize the interactive potential of the virtual reality by mirroring the interior monologue and multi-linear storytelling techniques of Ulysses directly.

The setting enforces the users sense of having a distinct goal or objective, because their choices are resulting in visible changes to the environment and will affect what level they progress to, whilst others will not. This encourages the user to be more engaged with the environment because they will be seeing a direct effect. This provokes more interest in learning about the network that underpins the characters relationships. As shown above, completing these interactions in a particular order will change the outward environment and the possibility for new interaction events to occur within specific missions. The environment emulates these effects in real-time, so that choices percolate down to the users understandings of chronological time and the overall structure of the environment. It draws the users attention towards the system governing their immediate interactions within the environment as part of a wider overall context, as Joyce did with the story of Ulysses.

This real-time effect foregrounds the objectives of the environment; it focuses specifically on what drives or motivates the player in the environment and what mechanisms are being used to direct their attention. The real-time effect also focuses on how to make the user aware of the fact that they are being directed towards discrete learning goals, having both a specific and general goal. The

objective-based environment is themed around Joyce's use of key sound events and so the environment uses certain cues or tropes from Joyce's work, namely representing how sound cues interact with the interior monologue and multi-linear storytelling techniques. Use of songs mentioned in Joyce's work and advertising motifs help to establish the Victorian setting of the environment (such as the Gold Leaf Cigarettes advertisement for example), by establishing it within the time period using references from *Ulysses*.

4. Itinerary

Aspects of the Unity game engine functionality explored in the project included: exporting of rigged mecanim animation models into Unity and the use of specific textures and geometry from the 3DS-MAX city assets. It was necessary to investigate the viability of moving the large models into the game without taking up too much disk space or RAM. A method was used that significantly reduced the overhead of rendering the models; exporting and saving the city models and their textures in Unity .fbx and .fbm formats respectively rather than as native 3DS-MAX files in the .obj format.

Prefabs are a generic feature of games engines that allow a developer to group game objects together into packages that can be quickly instantiated in the game environment. These packages are employed in situations where they can lighten the load on the processor and enable reusability of the assets employed in development. This functionality enables a convenient hypostasis effect referred to as inheritance, where the designer can implement changes to a specific asset or can make changes backwards compatible to all instances of an asset. In Unity3D Prefabs designated in the Hierarchy view hold an active reference to the Prefab even when they are not being rendered by the engine.

The inheritance functionality affects the way Prefabs are rendered by the engine. The engine decides what instance of a Prefab to instantiate based on instructions predicated in the Hierarchy and through use of scripting. The engine will then decide how to instantiate a Prefab based on these instructions and will make that decision from how instantiation will affect other instances of a Prefab, even those not being used in a scene. Sometimes the engine will derive specific operations in temporary memory, in order to facilitate the instantiation of several Prefabs. The intention of the system was to make the Unity engine as autonomous as possible, requiring little coding by the developer outside Unity's native MonoDevelop suite.

A careful designer can use the system to significantly save memory if the bundles of Prefabs have pre-determined execution subroutines. For most commercial engines the emphasis is on increasing speed of execution and rendering, rather than prioritizing on the engine's use of memory, in both short term and long term operations. This feature is useful in a setting where multiple operations occur at different times and need to be coordinated, prolonged, or prioritized over the execution of others, like in the *I-Ulysses* project. Modern games achieve a more extensive means of asset co-ordination by employing multiple

threads of code. The computer game industry has a focus on creating console CPUs with more cores that can execute more threads.

With the use of Unity Prefabs it becomes possible to create variations in running procedures responsible for the simultaneous generation of graphics, sound, text and the loading of new scenes, without the need for multi-threading. When creating multiple levels and an unfolding structure this functionality is highly useful, especially when working in a format with limited overhead, like i-phone or other portable device. This is the type of graphical interface that the I-Ulysses project employs; the finished environment could be run on a variety of smaller formats, such as i-phone apps or on i-pad, or other smartphone formats.

Each waypoint is represented by an object or asset in the running environment. These are designated as a Prefab. Each waypoint has a script attached to it listing it as an array, with a specific position for the waypoint in the city so the game object does not need to be represented in the Hierarchy. This script has a collider function which tells the object to destroy itself when the player tagged as Player moves into proximity with it. The script then instantiates another object, a second waypoint, which is also part of the array. This Waypoint update function has a similar instruction that updates the current waypoint number to a variable integer (0-1) representing the waypoint, and which changes the player tag to something different. Depending on the tag of the player, different outcomes are observable in the position of the waypoints; directing the users navigation through the environment. This is done in real-time by updating the waypoint location in a straight line, or displaced across several locations.

As all paths still lead to the same outcomes in terms of the interactions and the levels to which they lead, this means that the player will go in one of several directions following the Waypoints, like a conventional narrative. In subsequent levels of the environment these tags govern a sophisticated range of interactions such as what the map displays, what imagery plays in the characters thought bubble, or the emanation of sound effects. The player perceives that there are a larger number of outcomes, derived from a small number of player choices within each level. There are not an infinite number of actions in the environment, but the cross-extensibility of sound, spatial and text-based information, immerses the user in the environment: as J.M. Dondlinger states, effective game design gives players the perception they have free will, even though at any time their options are actually quite limited (6). The tagging system is employed in commercial games to facilitate a wide variety of data variables, in the I-Ulysses environment it is used to govern the interaction between different sets of audio-visual and acoustical information.

5. A Cross-Section

What follows is a specific example of a story cross-section, adapted from the book. In the following example, the user is introduced to some of the first instances of the interior monologue in the environment. The interior monologue is the mechanism by which Joyce shows us the inner-world and thoughts of the character. As Tom Rochford (one of the characters) is manipulating the

record machine his physical actions are noted by the narrator, which the user can hear as they play through the level. These physical actions are contrasted with the mechanism of the record player. Tom's thoughts about the process are interspersed throughout the narration: say its turn six. In here, see. Turn Now On, it is as if he were talking to the machine, giving it directions. This portion of the dialogue is featured in both Tom Kernan and Blooms episodes of the environment; it reveals key relationships between several of the characters and, as they discuss Bloom, Bloom walks past places in the environment that are mentioned in the dialogue (see Fig 2). It is at this point that the user transitions between Bloom and Kernan, as playable characters.

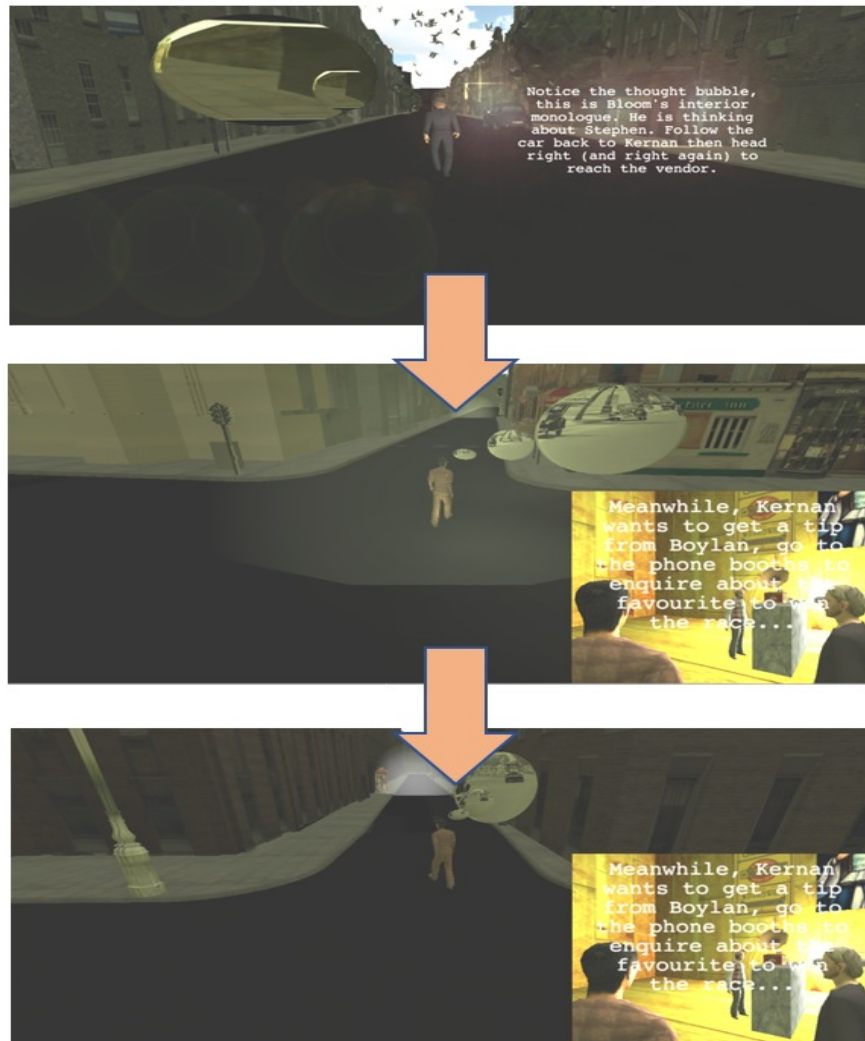


Fig 2. In this story arc the user hears the dialogue in the first section while playing as Bloom. Later, the user clicks on the gramophone icon as Kernan and they can see the actual discussion taking place concerning Bloom.

This arc creates an important link between events from the book, because it is an example of Joyce's use of multiple points of view, or opinions, on the same events and characters. As Rochford changes the disks Nosey Flynn and Lenehan talk about the mechanism; it is difficult to separate out relevant dialogue and narration, particularly when it cuts, like a film, to the description of the outside world in the following paragraph. The concepts discussed in this cross-section form a part of the instructional mode of a blended learning framework, wherein a tutor can read this section of the book, draw attention to the key techniques and then visually demonstrate this through having a student play the game.

The benefit of having an interactive virtual model is that its use emphasizes the participatory learning dimensions of the blended learning framework. It gives the tutor a format that is a step beyond what is possible with the Digital Companion or E-Book format because it is interactive and recursive. The objective of the instructional imperative of the blended learning model is for a tutor to be involved, as much as possible, in guiding the class towards discrete learning goals. The I-Ulysses project, for this reason, ultimately represents a model or a tool that a tutor can employ alongside a teaching curriculum, but is not designed to replace a conventional curriculum or provide an alternative form for it. The primary goal of the I-Ulysses project is that it functions independently as a virtual environment that a user can interact with and learn about Joyces work from. This means that the operational aspects of the environment require a different set of developmental criteria from what would be involved in developing an educational website, an E-Book or a Digital Companion.

The I-Ulysses environment has a virtual design emphasis, unlike the Digital Companion and E-Book formats. By engaging with the environment, the user learns about the book through the design elements of the environment. While a tutor is interacting with the environment or using it as part of classroom activity, such as a reading, they can focus in on specific facets of the book while not disrupting the flow of the experience. The virtual scenarios were based on the author's interaction with students and tutors, who have taught Joyce and were informed by several user-test samples and focus groups that focused on improving the interface by having it tested, as much as possible. In total there were seven samples; a total of eighteen students of English from National University of Ireland Galway, thirty students from the University of Vienna, nine students from the School of Computer Science, in Trinity College Dublin and members of the public on several occasions, at the James Joyce Centre in Dublin, Ireland. The first sample at the James Joyce Centre consisted of seven participants: they were Joyce enthusiasts, a journalist writing for a national newspaper and students at University College Dublin, studying Joyce. The subsequent samples consisted of seven and five participants respectively, all of whom were members of the general public with no extensive knowledge of Joyce. Each sample played the game and filled out a questionnaire, detailing areas that they felt needed improving.

In the introduction it was noted that the main objective of the environment would be to facilitate the users understandings of the innovative storytelling techniques that Joyce employed in Ulysses. This list of learning outcomes was

derived by compiling each of the unique storytelling devices employed by Joyce and dividing them into three broad effects or modes: the interior monologue (or thought bubble), the multi-linear storytelling technique and the use of back stories. The responses of the attendees from the focus groups created a re-evaluation of the initial stated learning outcomes, referred to now as learning objectives. By interacting with the environment the users from the groups were better able to:

A) Note the difference between interior monologue segments from *Ulysses*, the dialogue and the environment in a visualized, aural context.

B) Discern the characters motives, in an educational context.

C) Explore the back stories of each character in a way that connected their shared experiences to the wider environment of the city.

D) Discover more about the cultural world of Joyce's *Ulysses* and Joyce's main works, in an educational context.

E) Describe a multi-linear perspective on the events of the chapter, rather than focusing on a single story-facet at one time in one place.

F) Describe the events of *Wandering Rocks* in a way that emphasized the space, setting, use of sound effects and the interconnectedness of key events and characters from the book.

G) Evaluate how Joyce used sound to connect events across different spatial, geographical and temporal locations in the city.

The respondent samples stated that being able to see the difference between the characters imagination and reality, while having corresponding thought bubbles to delineate these elements of the experience, made the experience more enjoyable and informative in the context of seeing the technique represented from the book in a virtual format.

The respondents also argued that they felt the use of the map and the presentation of the city provided a good overview of the space of the book and the character interactions occurring in it. The consensus was that the environment, from a graphical point of view, made an effective use of the urban environment and that it felt as if the user were walking around the actual space of Dublin. A respondent from the Vienna test noted that the ability to see the streets of Dublin in a visualized context, while also exploring the narrative of the book, made the experience of using the environment more engaging and was comparable to a walking guided tour of the area.

One of the primary areas of difficulty in the project was assessing and operationalizing the data extracted from the focus groups. In many cases the types of data gathered in the project were not formatted for a statistical evaluation; rather than exploring the mean data, information and insight gathered was more anecdotal than procedural. As Sandoval, McKenny and Reeves argue, a virtual reality format lends itself to novel forms of education-design; but because the subject matter of the I-Ulysses project is esoteric, specifically in relation to Joyces work, it is more difficult to assess the output of the project in a scalable format like Conjecture Mapping (see Fig 3 below).

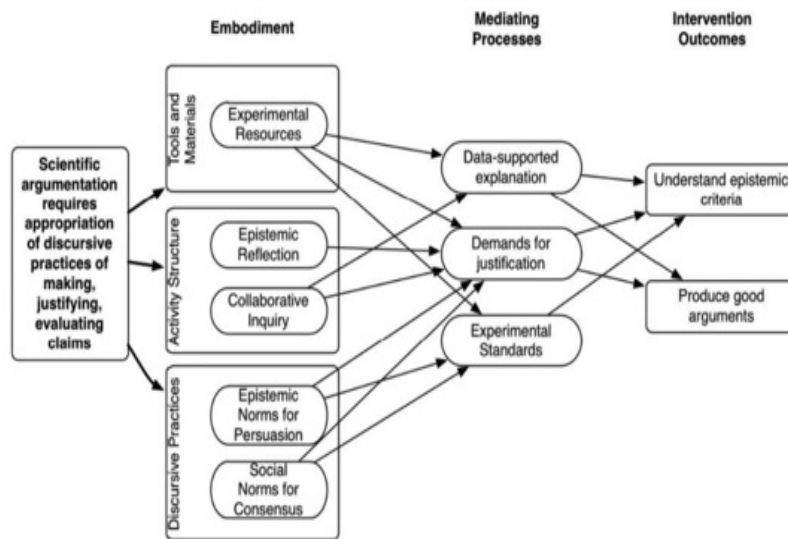


Fig 3. Sandoval provides an example of the previous Educational Design Conjecture Map that has gone through the Iterative process.

Where the mapping format and education-design theories were useful, however, was in providing the template for an Iterative design process, whereby the process and practice of the project underwent significant revision, which integrated a discourse involving both the content of Joyce’s work and the employment of virtual reality technologies. This is ultimately why the project benefited from having explored commercial and technological underpinnings, in the EI-commercialization study and academic placement, because they provided an opportunity to test the design-hypothesis and ‘High-Level Conjecture’ of the project in a real-world setting.

Without this data and the data gained from the focus groups, the project might potentially have only focused on a single facet of the design-hypothesis at a given time. Where the I-Ulysses project sought to break new ground

was in offering the potential for the design-process to be externalized into the format of the learning environment; incorporating both the Joyce-focused and technology-focused aspects of the project simultaneously. This externalization provided another layer of engagement that reflects the type of continuous and recursive engagement that readers traditionally have with Ulysses. The learning environment can aid the efforts of a tutor attempting to teach Ulysses in a classroom environment by facilitating recursive engagement, while mediating the multi-modal content of the book.

There are also potential areas for improvement in the I-Ulysses project; in terms of design emphasis and methodological focus, the primary objective of the project was to establish a functional interface for the implementation of 3-D game assets that would resemble and reflect key elements of the content of Ulysses. However, there are other areas of the project that could be focused on, in a more developed format. One such area is the use of sophisticated rendering technology to reproduce an architecturally authentic Georgian-era Dublin, for the benefit of tourism and cultural heritage. In Fig. 4 below examples of what the environment could look like are shown using models developed by NOHO (a 3-D technologies company) as part of their pre-1916 'Virtual Dublin Project' and a model of Christ Church.

Another area that the project explored was the granularity of the game-assets employed in its development; the manipulation of its pre-existing hierarchy, whereby tutors could update the system in real-time and instantiate instances of player avatars or thought-bubbles, reflecting their own educational design-architecture and the students engagement with the content. In the formats indicated in Fig. 5 and 6 below, it would be possible for the tutor to update modules for player avatar appearance; what the thought bubbles would show and to re-format aspects of the environments design and realization, reflecting an ongoing discourse.

The data employed in this hierarchy would allow such to occur in an online server-based context, thus expanding the horizons of the project into something more closely resembling an online community, or an archive or repository of digital knowledge maintained by its subscribers. This educational-design architecture maps key features of the educational-design curriculums proposed by Sandoval, McKenny and Reeves; positioning them in a live, practical context, which could conceivably connect with other online resources.

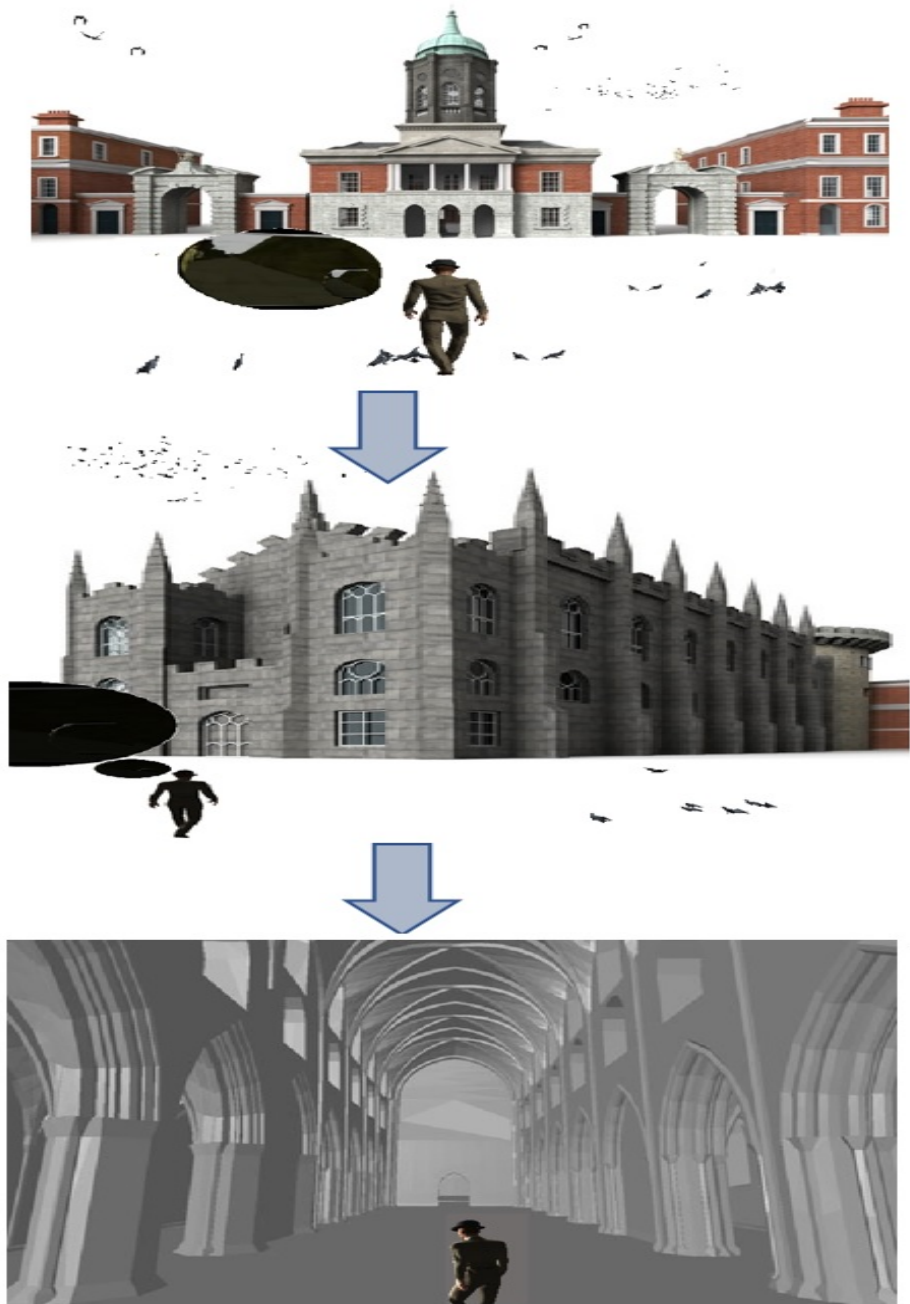


Fig 4. Bloom walking around Georgian-era Dublin Castle and Christ Church.

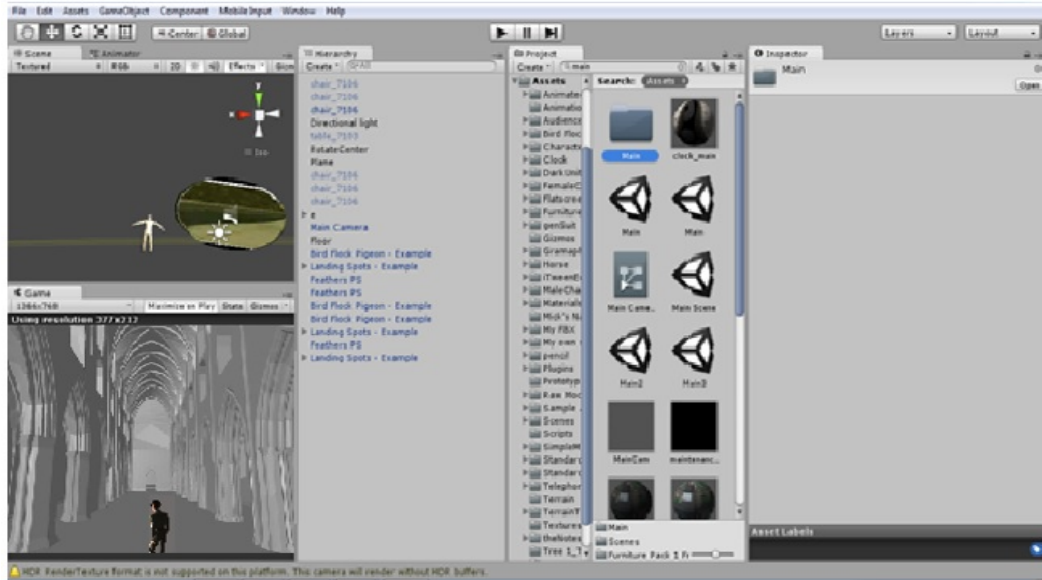




Fig 5. The Unity Interface.




Control of the Character

- Thought Bubble
- Player Avatar



Educational Design Interface

- User Manipulates Elements
- Can Update Design Architecture in Real-Time



Unity Interface

- Prefab Hierarchy
- Modular Design

Fig 6. Map of Key Elements that the user can instantiate.

6. Conclusions

The main objective of the project was to explore new ways for a user to learn about aspects of Joyce's work, using a virtual model. The project adapted key aspects of Joyce's storytelling techniques and made them conceptually easier for a user to understand. The scenarios that the user learned about were described and discussed; the techniques that the environment adapted were noted and catalogued in the Cross Section section. The environment thus is aimed to be helpful to a tutor on a course teaching Joyce, but it is also intended to be an entertaining experience that can be used as a virtual reality experience.

Feedback from the user tests indicated that the project delivered in providing an informative, educational guide to *Ulysses* that would appeal to academics and casual readers of the book. The most important aspect of the project to emphasize, however, is that while it represents a guide to the book, it is also primarily a virtual reality experience. The project researched the areas of overlap between game media, virtual reality and literature. In this regard, it could form an effective template for adapting different kinds of literary narratives into virtual reality formats. The practical work done on the project was about demonstrating how to do this most effectively, with the most efficient use of resources possible.

In the Methods section specific methodologies were outlined in respect of serious learning, while in Itinerary there was discussion of how these methods were adapted with Unity. In the Introduction several key objectives were outlined with a view to the use of a virtual reality model for understanding literature. The choice of a virtual reality model has the distinct advantages of separating physical space and narrative, enabling the user to interrogate the differences between historical, narrative space and physical space. One of the main objectives of the project was to provide the user with a virtual model that adapts the techniques that writers employ. The I-Ulysses environment remodels and remediates these techniques into a multi-linear, 3-D game experience.

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