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Discovering Nature through Mobile Gaming

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ABSTRACT

Casual video games and nature outreach face similar challenges when engaging audiences, and may have much to offer one another from within their respective realms. The aims of this project were to examine casual mobile video games as a means of encouraging engagement with nature, as well as whether factual content has a place within the non-serious gaming industry. This was achieved through two studies using the commercially successful free-to-play game *Flutter: Butterfly Sanctuary*. Quantitative player metrics and qualitative self-report methods drew results from over 180,000 active players and were used to assess engagement through sub-factors relating to learning and interest. While a direct measure of learning remained elusive, an analysis of metrics results revealed players to be performing very well at identifying species within the context of the game. Supporting survey analyses revealed Flutter to extend interest in butterflies beyond the game with some groups. Additional results revealed players to be engaging with the factual content, and identifying it as a positive factor when making decisions about sharing and spending. It was also revealed that many players had difficulty distinguishing non-factual from factual elements within the game. On the basis of these results, I conclude that games like Flutter may help sustain engagement with real world content, which in turn can be responsibly utilised by game developers to engage and offer depth to their audience.

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CHAPTER 1: NATURE, GAMING, AND ENGAGEMENT

1.1. Introduction

1.1.1. FRAMING THE PROBLEM

An effective method for getting people interested in nature is exposure to it in a natural setting (Cuthbertson, Socha, & Potter, 2004; Louv, 2005). But what happens when people don't value those outward experiences enough to initiate them? Studies suggest that urban living environments, varying income, and increased use of digital technology may all have negative impacts on both interest and access to natural environments (Pergams & Zaradic, 2008; Stevenson et al., 2014), leading to reports of both children and adults becoming increasingly disengaged with nature (Louv, 2005; Pergams & Zaradic, 2008). To compensate for these trends, informal nature centres (such as parks, zoos, aquariums, etc.), citizen science projects, and outdoor education curricula, use various forms of technology to help promote discovery and education in outdoor settings. Some examples include geocaching websites, photo sharing apps, and digital identification guides (Chavez, 2009; Dickinson et al., 2012; Hwang, Yang, & Wang, 2013; Lai, Chang, Wen-Shiane, Fan, & Wu, 2013; Uzunboylu, Cavus, & Ercag, 2009). While these represent innovative and useful components of nature re-engagement campaigns, each of these methods focuses on getting people to go outside of their regular experience, instead of encouraging their continued engagement throughout their day-to-day setting. This overlooks the problems presented by limited access to the natural world and misses one of the more popular growth areas within the technology sector: casual mobile gaming.

1.1.2. RESEARCH QUESTIONS AND BACKGROUND

Within this thesis I will investigate whether popular free-to-play gaming technology has a role to play when engaging adult audiences with natural world content by exploring how games including factual content may contribute to engagement with both this the content and with the natural world. This will be achieved through two studies which ask whether young adults learn within an entertainment focused setting, and whether the inclusion of factual content impacts their interest in the game or with the natural world beyond. Both studies

rely on game metrics and survey data collected from the commercially successful *Flutter: Butterfly Sanctuary.* What makes Flutter such an ideal case study is that it has been designed primarily for the purpose of entertainment, but includes real world species and factual content. Of particular relevance to nature communicators and game developers (defined later) is that these studies align with identifiable gaps in each set of literature.

I come to this project with a strong personal connection to the outdoors, working experience in museum settings, and a background education in Computer Science. During my undergraduate studies, I researched gaming technology as a way of connecting adolescents to nature outside the classroom by trying to recreate my personal experiences in a digital medium. This multidisciplinary approach led me to working at a science centre in Seattle, where I realised my personal experiences were not always going to be relatable to urban audiences. I became aware of how pervasive casual gaming had become in people's lives through mobile devices, and began reframing concepts from informal education into questions I could explore within technology. I adapted the question posed earlier by Falk and Dierking (2000):

> *How does this museum, exhibition, or lecture contribute to what someone knows, believes, feels, or is capable of doing? (Falk & Dierking, 2000, p. 12)*

I wanted to know specifically whether games and can be used to contribute to attitudes and understanding of nature, and if so, how. This led me to Science Communication at the University of Otago where, through connections with the documentary film-making company Natural History New Zealand (NHNZ), I was connected with their games division Runaway Play. Given their interest in making games infused with elements of nature, I began an internship and was given access to data and staff time behind the commercially successful game *Flutter: Butterfly Sanctuary*. Flutter was just over one year old, and was performing well within a market dominated by short-lived, easy to play games. Its target demographic was young adult audiences, and reach seemed to overlap with groups reportedly becoming more disengaged with nature (Louv, 2005). These elements made it an ideal platform for exploring both the influence that the nature related content was having on players, but also whether it may be helping to extend their interest to

real species. This is the framing for this thesis, and while I remain close to the material and ideology, I wanted to use my access to ask questions of engagement that could reveal both positive and negative impacts on the target audience.

As was documented in the book *Last Child in the Woods* (Louv, 2005), much of the research surrounding engagement with nature is focused on children, with concerns raised over whether those children will engage with nature as adults. It is my intention that my research will encourage further studies on reaching young adult audiences, which I perceive to be central to the disengagement problem. Additionally, evidence suggests that any well designed game has the potential to place the player in an ideal state for learning (Chen, 2007; Csikszentmihalyi, 1991; Shute, Ventura, & Ke, 2015; Wiebe, Lamb, Hardy, & Sharek, 2014), but rarely do these effects become the focus of studies outside games explicitly involved in education (Baniqued et al., 2013; Shute et al., 2015). This apparent gap in the literature is yet another area that I am hoping to contribute to, both as a contribution to gaming literature, but also for the consideration of game players.

1.2. Definitions and Scope

1.2.1. WHAT IS "NATURE"?

"Nature" is an ambiguous term that has been addressed through many lenses and contexts. For the sake of this thesis, "nature" will primarily be applied to the discussion of non-human environments and organisms. Although the simulation of ecosystems and complicated interspecies interactions will be generally considered, these fall beyond the scope of material included in case study, and therefore will largely be left out of this definition. Finally, while it is acknowledged that humanity exists as a part of the natural world setting, including this as part of the definition would serve little purpose to this analysis of engagement.

1.2.2. NATURE COMMUNICATORS

The term "nature communicators" is used within this thesis to relate to a number of different groups, all sharing an interest in the preservation of natural environments and the communication of such environments to varying audiences. Formal education, through the areas of outdoor education, make-up one particular group within this cluster, as do informal educators in relation to nature centres, museums, parks, or conservation agencies. Practitioners in the field of Science Communication are also represented, particularly when associated with public

engagement with nature, biology, ecology, or other environmentally related citizen science projects. Although varying in approach and emphasis, each of these groups share a focus on natural world outreach, and are challenged by maintaining public engagement through the issues of interest and access.

1.2.3. GAME DEVELOPERS

Like the nature communicators described above, "game developers" represent a broad grouping of individuals who share similar desired outcomes ranging from game design, production, to implementation. Within this thesis, these outcomes are more closely related to the inception and creation of digital games, with focus on casual gaming for both entertainment and education. In stating this, it should be acknowledged that the term 'video game' is equally ambiguous, and should be regarded specifically within the context it is being used. As Bavelier et al. (2011) point out:

> *"There are millions of individual games, hundreds of distinct genres and sub-genres, and they can be played on computers, consoles, hand-held devices and cell phones." (Bavelier et al., 2011)*

In other-words, addressing video-games in general is ambiguous at best, and efforts will be made to offer clarity throughout this document.

1.3. Perspectives on Engagement

In a novel analysis, Bensaude Vincent (2014) examined the term 'public engagement' through its role as a buzzword, proposing that at its core, engagement functions at an intersection of different values and ideas. This analysis becomes increasingly apparent when investigating engagement as applied to games, to engagement with nature. Although both video game developers and nature communicators discuss concepts relating to cognition, emotion, and behaviour, they do so from fairly different backgrounds. Nature centres (such as zoos, aquariums, science centres, and other outdoor education sites) tend to draw from definitions within formal and informal education. These rely heavily on theoretical models relating to "student engagement" (Christenson, Reschly, & Wylie, 2012; Ors, 2012; Shernoff, 2013), as well as the communication models represented by the term "public engagement" from Science Communication (Bensaude Vincent, 2014; Dickinson et al., 2012; McCallie et al., 2009). The video game industry, however, generally applies a more pragmatic approach, focusing on models and instruments

developed to measure psychological outcomes under the banner of "user engagement" (Csikszentmihalyi, 1991; Lehmann, Lalmas, Yom-Tov, & Dupret, 2012; Norris, Weger, Bullinger, & Bowers, 2014; O'Brien & Toms, 2008).

Regardless of field or background, researchers investigating the various forms of engagement regularly call for clearer definitions (Appleton, Christenson, & Furlong, 2008; McCallie et al., 2009; O'Brien & Toms, 2008; Shernoff, 2013). Shernoff (2013) and Appleton et al. (2008) both discuss the need and benefits of a consolidated theoretical definition for eduction, addressing how it would provide the first steps to creating better measurement tools within education. This concept seems well supported by research within the gaming industry, where its implementation has led to the development and analysis of a number of different 'user engagement scales' (Lehmann et al., 2012; Norris et al., 2014; O'Brien & Toms, 2013; Sweetser & Wyeth, 2005; Wiebe et al., 2014). Finally, the work of Rowe et al. (2008) on "public engagement" expands the practicality of clear definitions, by relating to engagement as a process, or method for understanding broader outcomes related to each field. Thus, in order to apply 'engagement' to questions spanning science communication, formal education, and gaming, one must first identify the key points ascribed to each usage.

1.3.1. VIEWS FROM SCIENCE COMMUNICATION

From the three major views from the realms addressed in this thesis, the broadest definitions for engagement seem to fall under the term 'public engagement', which takes three prominent forms within Science Communication literature. The first is understood through the concept of participatory democracy, also known as public participation, which aims to facilitate a dialogue between scientists, policy makers, and the 'general public' (Felt & Fochler, 2010; Lengwiler, 2008). In this context, creating dialogue is key, and is assessed through outcomes in policy and civic participation. This is illustrated through Rowe et al. (2005) who suggest that public participation is:

> *"[t]he practice of involving members of the public in the agenda-setting, decision-making, and policy-forming activities of organisations/ institutions responsible for policy development." (Rowe & Frewer, 2005)*

The second form of 'public engagement' can be related to institutional definitions. These are something of an organisational brand of engagement, and are often defined individually. In some cases, this can be as broad as attracting 'public' attendance or input, regardless of evaluation (Rowe et al., 2008). More practically, however, engagement within this context has also been related to a 'state of connection' with a given topic, which serves to motivate or generate interest to further discovery on the part of the individual (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007).

The third usage of the term 'public engagement' that is relevant to this study borrows from models in formal education. This are centred on learning and feelings toward learning in students (Lorenzoni et al., 2007, p. 19; McCallie et al., 2009, p. 19).

1.3.2. VIEWS FROM FORMAL EDUCATION

Situated within one of the oldest theoretical discussions on engagement, formal education has produced several relevant constructs relating to student engagement, as well as disengagement, with regard to learning and school curriculum (Finn, 1989; Fredricks, Blumenfeld, & Paris, 2004; Shernoff & Schmidt, 2008). In its traditional form, student engagement was originally described through its opposite, disengagement, and was identified as a construct consisting of two core concepts containing both emotional and behavioural factors (Finn, 1989). This two concept model was later refined to contain a cognitive component (Fredricks et al., 2004), and refocused into the positive aspects of student learning relating to interest and deeper personal connections on the part of the learner (Appleton et al., 2008; Harlow, Debacker, & Crowson, 2011; Shernoff & Schmidt, 2008). Although each construct is likely to contain many sub-factors, it is commonly discussed that student engagement contributes to the interest and learning of individuals (Appleton et al., 2008), and can be represented through cognitive, psychological/emotional/affective, and behavioural engagement components (Shernoff, 2013, pp. 49-50).

1.3.3. VIEWS FROM GAME DEVELOPMENT

Game development, like the 'public engagement' models discussed earlier, borrows some of its theoretical definitions from formal education (Appleton et al., 2008; Fredricks et al., 2004), but also relies heavily on psychological constructs of 'user engagement' and Flow Theory (Csikszentmihalyi, 1991). As O'Brien and Toms (2008) observe, there is not a clear definition for the construct of 'user engagement' itself, although generally it is described as the positive experiences and motivations between users and technology (Lehmann et al., 2012; Li, Jiang, Tan, & Wei, 2014; Wiebe et al., 2014). While ambiguous, this definition has allowed for the development of several measurement scales, such as the User Engagement Scale (O'Brien & Toms, 2013) and GameFlow Measure (Sweetser & Wyeth, 2005), both of which are heavily influenced by Flow Theory. As a psychological state, Flow Theory attempts to explain moments of intense focus and timeless engagement one experiences when performing a sufficiently challenging task (Csíkszentmihályi, 1991). This is a state regularly observed in game players (Admiraal, Huizenga, Akkerman, & Dam, 2011; Boyle, Connolly, Hainey, & Boyle, 2012; Sweetser, Johnson, Wyeth, & Ozdowska, 2012) and has been associated with ideal learning environments (Csikszentmihalyi, 1991; Shernoff, 2013). Because of this, it has been added to the combined definitions for 'user engagement', as studies using Flow Theory often seek to recreate this state in game players (Admiraal et al., 2011; Boyle et al., 2012; Csikszentmihalyi, 1991).

Combining each of the different perspectives above, O'Brien & Toms (2008) provide a useful assessment of 'user engagement' measures where aspects of emotional affect, motivation, challenge, feedback, focused attention, sensory appeal, and interest are summarised and central to the understanding of engagement within their field. It is the last component, "interest", that seems to be key in providing a more direct link between the gaming field, education, and 'public engagement'.

1.3.4. COMMONALITIES BETWEEN THE VIEWS

Whether applied to public dialogue, disinterested students, or emotional associations with games, encouraging and maintaining interest can be viewed as a central component to each definition of engagement. Often related to aspects of learning, interest can be summarised as a "core psychological process" (Appleton et al., 2008; Christenson et al., 2012; Fredricks et al., 2004) and discussed as one of the primary objectives associated with nature centres and informal education sites (Davies, 2013; McCallie et al., 2009). As a psychological component, personal interest has been included within the concept of Flow (Csikszentmihalyi, 1991), and is readily used in game testing as an observational measure, as well as in attitude studies in science communication (European Commission, 2010; Norris et al., 2014; O'Brien & Toms, 2013; Sweetser & Wyeth, 2005; Wiebe et al., 2014). Furthermore, Whitmarsh et al. (2011), Hazel et al. (2013), and Appleton et al. (2006) also demonstrate qualitative measurement tools utilising interest as it applies to personal associations and learning outcomes.

Learning can be thought of as another key link between the realms, and is part of the process of developing personal interest leading to engagement (Falk & Dierking, 2000; Hidi & Renninger, 2006). Clearly relevant to the cognitive assessments in formal education (Bloom, 1956; Marzano & Kendall, 2007), Rowe et al. (2008) and Connolly (2012) also identify the value of learning to their audiences in informal education and gaming. From studies into 'public engagement', the question of what people are learning tends be manifested through audience responses, particularly relating to their positive associations, or sense of influence and understanding. Positive associations with what audiences have learned also overlap with casual entertainment gaming. Already identified as a core component of entertainment focused games (Baniqued et al., 2013; Connolly et al., 2012), learning also provides an avenue for studying retention and re-engagement (Azevedo, 2011; Hidi & Renninger, 2006).

1.3.5. ENGAGEMENT WITHIN THIS THESIS

Although there are many different ways of analysing engagement, I'm focusing on outcomes associated with interest and learning, interest for its role in sustained engagement and importance to nature communicators, and learning for its relationship within gaming literature and education. By focusing on these identifiable aspects as key components of engagement, I explore a potential pathway leading from the inclusion of factual content about elements of nature in games, to ideas of personal involvement and interest within the audience. This personal involvement and interest can then be used to discuss the role casual games might have on the broader challenges of engaging adults with nature, and in particular on helping to sustain interest while encouraging both awareness and new interest.

Furthermore, although learning has been clearly investigated for its relationship to serious and educational games, its effects on player engagement within entertainment has been less well defined. This is noteworthy as indications of its relevance to this realm are beginning to surface through reviews conducted by educators using "off the shelf" games (Charsky & Mims, 2008; Jong, Lee, Lee, & Shang, 2008; Phan, 2008; Shute, Ventura, & Ke, 2015), as well as some acknowledgement in reports from the gaming community itself (Mniszko, 2012). Tom Chatfield is quoted in the article titled *Can digital games and virtual worlds help us save nature?*:

> *"…the games industry has discovered that the most successful games of all are those that come closest to real life." (Mniszko, 2012)*

It would seem that the role learning plays in games may again feed back into player interest, both through the inclusion of fact-based content, but also by potentially creating an avenue for engagement beyond the screen.

1.4. Moving Forward

Video games and nature may seem like an unlikely pairing. However, each may have something to offer the other through their respective forms of engagement. As Dickey (2005) points out, games are successful because they are engaging. If viewed as a tool instead of a barrier, then perhaps they can provide opportunities for reengaging young adults with nature. These opportunities may complement or enhance the reach of nature communicators, or open new areas for game developers to become more actively involved. Additionally, the benefits of engaging adult audiences with real world content may also feed back to the game itself. In the following chapter, the case study Flutter will be given centre stage in order to address how key gameplay elements, as well as factual content, were used to assess learning and sustained interest in later studies contributing to the roles games may have when engaging young adults with nature.

CHAPTER 2: FLUTTER CASE STUDY DESCRIPTION

2.1. Introduction to Flutter's Game Design

As mentioned in the previous chapter, video games are not a one-size-fits-all field, and cater for an ever growing continuum of user demographics, genres, and platforms (Bavelier et al., 2011). In order to understand how Flutter relates to the questions of how games and nature might benefit from one another, I'll first have to explore where it sits within the market, as well as how factual content has been included in its gameplay. We'll do this by first providing some background on the central gaming models that Flutter represents as well as some of the decisions that went into its design and content. We'll then move more specifically into the components of Flutter's design, gameplay, and content that are relevant to the studies in this thesis.

2.1.1. "FREE-TO-PLAY" AND "CASUAL" GAMING

The term "casual gaming" generally refers to titles featuring easy-to-learn controls, which target more general audiences (Casual Games Association, 2013). There is no specific genre associated with casual gaming, but classic examples include Tetris, Solitaire, Minesweeper (Baniqued et al., 2013) as well as modern types like Limbo (Playdead, 2014), FarmVille (Zynga Inc., 2015), and Angry Birds (Rovio Entertainment Ltd., 2014). The "free-to-play" model is derived from casual games, and has been described as a 'deep revolution' within the gaming industry, in that it provides an easily learned gaming experience at no cost, while encouraging monetisation through small repeated transactions within the game (Luban, 2011; Michaud, 2009). Focused on short-repeat interactions, ranging from 30 second to 20 minutes, this model tends to be particularly appealing to 'non-gamers' (Casual Games Association, 2013; Michaud, 2009), and encourages continued engagement through its simple gameplay and interface.

2.1.2. FLUTTER AND "INSPIRED BY NATURE" DESIGN

> *"Care for your own rainforest and raise butterflies through their incredible life cycle. Use your touch to bring light and life into the environment and assemble spectacular butterfly collections!"*
> *(Runaway, 2015)*

Flutter: Butterfly Sanctuary is a game built for Apple and Google mobile devices, that encourages players to collect digital butterflies within their own digital butterfly sanctuary. Designed by a team at Runaway, a branch of Natural History New Zealand (NHNZ), Flutter uses stylised artistic content, as well as a free-to-play casual gaming structure, to reach a target audience of 18-35 year-old North-American females. Like other casual games in its field, the objectives of Flutter are simply to collect points and creatures, but unlike other games, Flutter uses factual content as part of its core design. This sets it apart from other games, and makes it a relevant case study for exploring learning and interest in nature.

As a branch of NHNZ, Runaway has close ties to natural history, but produces for entertainment and not education. As such, it has fused many common game development practices with its "inspired by nature" design process creating a commercially viable product. To the team at Runaway, "inspired by nature" implies a focus on the gaming experience, while relying on elements found in the natural world for content and design. Although Flutter contains factually based content, the game itself does not target a specific learning outcome, which separates it from educational and serious games. These are often defined by their emphasis on learning, and generally take the form of simulations or highly structured gaming situations (Connolly et al., 2012). Furthermore, the Runaway team was inspired by their time spent interacting with staff at tropical butterfly houses, such as the one found at the Otago Museum in Dunedin. Through these interactions, the game designers gained exposure to the behaviours and life-cycle of living butterflies, and access to a simulated tropical environment. These inspired much of the look and feel within the game, as well as much of the chosen factual content.

2.1.3. FACTUAL AND NON-FACTUAL CONTENT IN FLUTTER

Factual content can be found throughout many of the screens and menus in Flutter (figures 2.1 to 2.3). Every butterfly within the game has been artistically rendered to resemble their real-world counterpart, Factual elements on their corresponding screen or menu include the butterfly wing patterns (1), common and scientific names (2, 3), the general home region of the butterfly (4), the relative size within a set (5), a unique fact (6), game characters like the Frog and Mission Bird (7), butterfly life cycle (8), and real-world flora species described as trophies or decorations (9).

While butterfly wing patterns are depicted accurately, their corresponding larva and pupa stages have not been accurately rendered. These and other non-factual elements have been included for gameplay purposes (Figures 2.4 and 2.5). Key non-factual elements include the colours and design of caterpillars (1) and chrysalids (2); the Attraction Flowers (3), used when crafting butterflies; the Wisp Mother event character (4); and the relative size of butterflies within the environment (5).



FIGURE 2.1: FACTUAL CONTENT FOUND ON THE PRIMARY PLAY SCREEN

Factual content found on the primary play screen (Sanctuary Screen) includes: (1) wing patterns; (2) common names; (7) game characters such as the frog and bird examples; (8) butterfly lifecycle; (9) real-world flora species trophies. (Copyright Runaway 2015)



FIGURE 2.2: FACTUAL CONTENT FOUND ON THE INVENTORY SCREEN

The Inventory Menu is organised alphabetically, but is difficult to search unless the player is familiar with the wing patterns (1) or common name (2). (Copyright Runaway 2015)



FIGURE 2.3: FACTUAL CONTENT FOUND ON OTHER PLAY SCREENS

Factual content is included on a number of pages in the Flutterpedia, but is difficult to search without prior knowledge. The content includes: (1) wing patterns; (2) common names; (3) scientific names; (4) butterfly home region; (5) relative size within a set; (6) unique fact; (7) game characters such as the frog and bird examples; (8) butterfly lifecycle; (9) real-world flora species trophies. (Copyright Runaway 2015)



FIGURE 2.4: KEY NON-FACTUAL CONTENT FOUND ON THE PRIMARY PLAY SCREEN

Non-factual content relevant to later studies can be found on the Sanctuary Screen and includes: (1) caterpillar pattern/colours; (2) chrysalis pattern/colours; (3) Attraction Flowers; (4) Wisp Mother character; (5) the relative size of butterflies within the environment. (Copyright Runaway 2015)



FIGURE 2.5: KEY NON-FACTUAL CONTENT FOUND ON OTHER PLAY SCREENS

Non-factual content relative to later chapters can be found within the Flutterpedia and Crafting menus, and includes: (1) caterpillar colour/pattern; (2) chrysalis colour/pattern; (3) Attraction Flowers. (Copyright Runaway 2015)

2.1.4. BENEFITS OF STUDYING FLUTTER

The choice of Flutter for this study stems from both to its position within the entertainment market and its use of factual content in design. Situated within the commercial casual gaming sector, Flutter targets an audience that may not be explicitly interested in factual content. It also has proven to be profitable, and has managed to rank highly in both Apple and Google application markets. Its inclusion of factual content, which although is not specifically intended for learning purposes, is also relevant in that exposure through the gaming platform may produce learning and interest outcomes. Finally, as is true with many free-to-play games, Flutter collects a great deal of data on player behaviours within the game, which makes it possible to perform analyses on learning outcomes across the greater population. This provides greater analysis than traditional studies.

Although not specifically examined in this research, many casual games, as well as nature outreach projects, struggle within a competitive commercial market. Having been on the market for nearly two years, Flutter continues to be profitable to both its producer and developer, while reporting increasing numbers of new

players, as well as a reasonably high retention of old. This aspect of Flutter alone is worth noting as it is evidence that the creators of Flutter have achieved a difficult balance within the casual gaming market, which may be related to its use of factual content, and "inspired by nature" designs.

2.2. Key Objectives, Screens, and Interactions in Flutter

Attempting to capture the experiences and interactions of a game on paper is exceedingly difficult, however there are components of Flutter that are explained in order to better understand the research of this thesis. An overview of goals and screens has been provided below, which forms the basis of more detailed descriptions found within the following chapters.

2.2.1. WHAT IS THE GOAL OF FLUTTER?

The general goal of playing Flutter is to collect points by creating and "levelling" new butterfly species. Levelling is the process of progressing a butterfly by unlocking its special abilities, and acquiring points. There is no maximum to the amount of points that can be accumulated, and in this way the game does not have a specific "end". Instead, a continuous supply of unique content is released in order to provide players with new challenges, and opportunities to set goals for themselves. These new challenges are known as Events, and add new collections of butterflies, hereafter referred to as sets, that can only be created for a limited amount of time. During an event, the player is then challenged to manage their points, time, and butterfly crafting items to try and create these species before the time runs out. Crafting items, known as Attraction Flowers, are the game's system for collecting butterflies and function like a recipe, with different combinations of flowers producing different eggs within a set of butterflies (described in 2.2.2). If a player is not able to collect each of the species within the time allotted, the related Attraction Flower will no longer be available, thus preserving the challenge element in an otherwise open-ended game.

2.2.2. SETS OF BUTTERFLIES

Collecting sets of butterflies is a key component to Flutter's gameplay. While Event Sets provide a continuous supply of content and challenge to players, there are also groups of butterflies which every player has the opportunity to collect. These are known as the Core Sets, and are butterflies players collect at the beginning of the game based on the number of points they have acquired. There are approximately 13 Core Sets within the game, consisting of about 53 individual butterflies. The bulk of the data analysed in this thesis is centred on these core sets, including the mission mini-game challenges that are described later in this chapter.

2.2.3. THE PRIMARY PLAY SCREEN

Flutter's main playing area is shown in Figure 2.6, here after referred to as the Sanctuary Screen, and contains links to all the other menus within the game. Designed to resemble a rainforest butterfly sanctuary, this is where most of the interactivity occurs, as well as where the currently active butterflies are displayed. On the Sanctuary Screen, butterflies can be manoeuvred through the environment, sent on Missions, and grown from eggs. Important items like Attraction Flowers, are also found here, which randomly reappear and can be collected by the player. The player's score and gaming currencies are shown on this screen, as well as access to the Main Menu, Crafting Menu, and Flutterpedia.

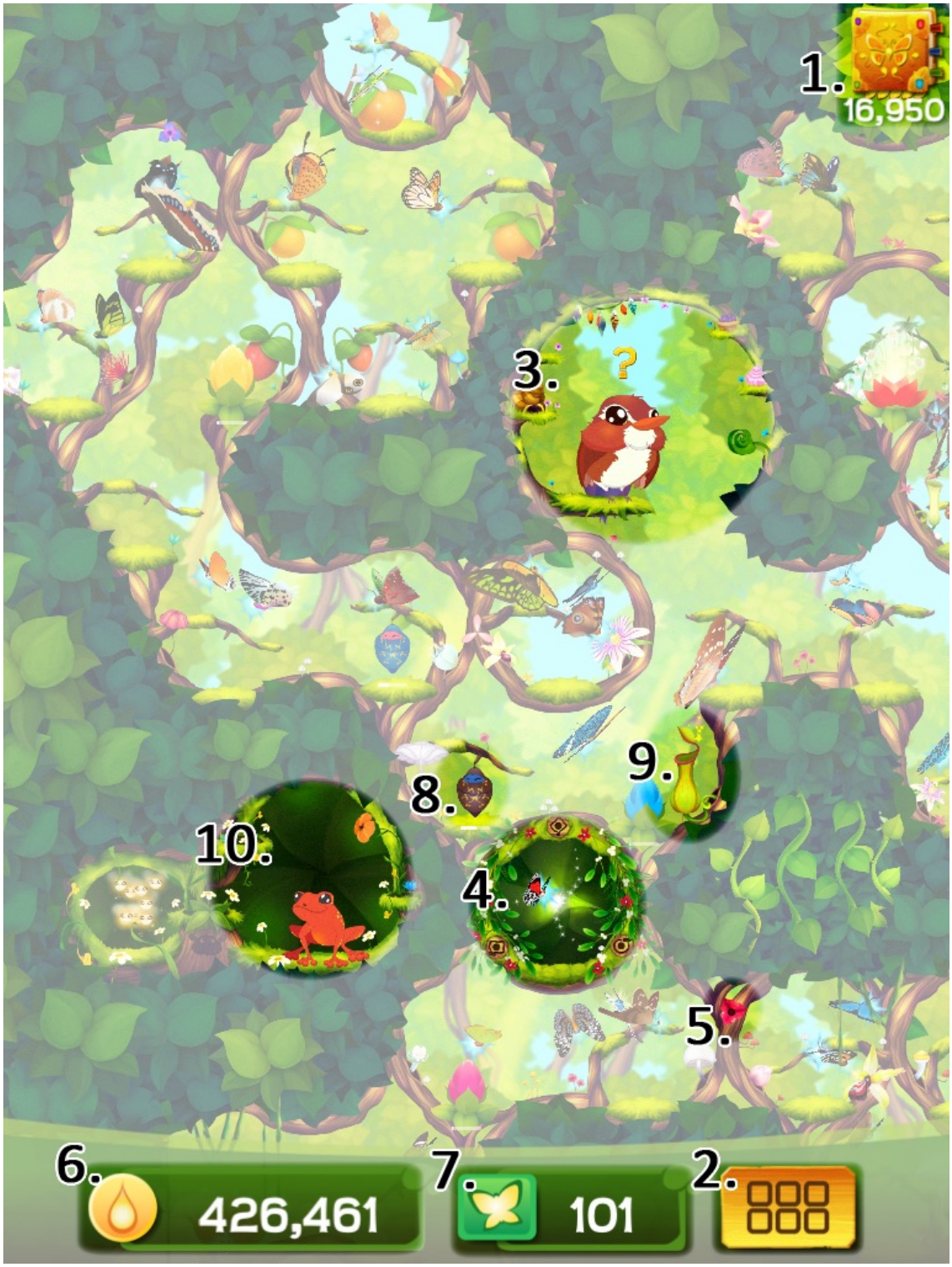


FIGURE 2.6: FLUTTER'S PRIMARY PLAY SCREEN

The Sanctuary Screen is the primary play area and includes many of the key elements for understanding the game including: (1) Score and Flutterpedia; (2) Main Menu Button; (3) Mission Bird Character; (4) Butterfly Crafting Area; (5) Attraction Flower example; (6) Soft Currency (aka. Honeydew); (7) Hard Currency (aka. Flutterbucks); (8) Growing Butterfly; (9) Example Game Trophy; (10) Poison Dart Frog Game Character. (Copyright Runaway 2015)

2.2.4. THE FLUTTER MISSION SYSTEM

A component of the Sanctuary Screen of particular relevance to this thesis is the Flutter Mission mini-game system. Once unlocked, this area provides opportunities for further interactions with active butterflies, by sending them to complete “missions” for small game rewards. Shown near the centre of Figure 2.6 the Madagascar Pygmy Kingfisher bird character can be activated by a player, and will then present them with a question, riddle, or clue relating to the butterflies currently active in the player’s Sanctuary. Each question the bird asks contains hints which can either be directly observed, or found within the Flutterpedia. Should players provide a butterfly matching the content of the question, they are given the opportunity to “Begin” the mission, with the chance of receiving a reward. If the player presents an unsuitable butterfly, the player is allowed to continue guessing for up to 24 hours when the question changes automatically. These interactions are presented in Figure 2.7. No penalty is incurred should the player continue guessing; the option of spending Flutterbucks to select another question is provided.



FIGURE 2.7: THREE MISSION BIRD INTERACTIONS

The Mission Bird character asks players to present butterflies matching hints shown in caps. There is no consequence for guessing incorrectly, but the mission reward can only be obtained after the correct butterfly has been identified from all the butterflies in the Sanctuary Screen.
(Copyright Runaway 2015)

2.2.5. THE FLUTTERPEDIA

The Flutterpedia is the factual reference resource for the game, and the location of much of the factual content. As the name implies, the Flutterpedia is styled after a book of knowledge, and is slowly unlocked as players complete achievements (Fig. 2.8). Divided into five different 'chapters', the Flutterpedia contains information about butterflies, information about non-butterfly characters, real-world flora decoration game trophies, mission challenges, and completed progress. Butterflies are displayed by their respective sets (Fig. 2.8), and will appear blank if the species has not yet been collected by the player. Once a butterfly is unlocked, a third page will appear containing images and facts. As butterflies are collected and progressed through their levels, different facts become visible to the player through an 'unlocking' process (Fig. 2.8). These facts include the common name, scientific name, general location, and a unique butterfly fact as described in Section 2.1.3. Similar content is available for the non-butterfly characters and decorations (Figure 2.3).



FIGURE 2.8: UNCOMPLETED FLUTTERPEDIA SET AND BUTTERFLY EXAMPLE

Butterfly sets are presented and unlocked in the Flutterpeida. The Amigo Set (bottom left) displays a yet to be unlocked butterfly, while the #68 Pipevine Swallowtail (right) has not yet been fully levelled to reveal its facts. (Copyright Runaway 2015)

2.2.6. THE MAIN MENU SCREEN

The Main Menu (Fig. 2.9) contains access to the inventory and social components of the game, as well as logistical components not relevant to these studies. The Inventory screen, shown in Figure 2.10, allows players the opportunity to manage their limited spaces. On this screen, the "Forest" tab represents butterflies currently active on the forest Sanctuary Screen, while the "Storage" tab is used to house extra butterflies the player has chosen to make inactive. These can be activated later, should the player choose. Of particular relevance is the information provided here, as this screen is yet another place outside the Flutterpedia from which players can view their butterflies, and receive limited factual content.

Apart from the Inventory screen, the Main Menu also houses relevant social and monetising components relevant to metrics and survey data presented in later chapters. The Friends and News sections encourage social interactions through Facebook, and connect players with Runaway through announcements. Players can also spend real and game currency within the Main Menu (Fig. 2.11). Flutterbucks are the primary currency, known as hard currency, and are directly related to US dollar amounts that players can purchase using their iTunes or Android payment methods. Honeydew is a secondary currency, or soft currency, which is collected from butterflies within the game, but can also be purchased with Flutterbucks. Flutterbucks can only be obtained through general gameplay under specific circumstances, making it the currency which players buy when needing to hurry or purchase other elements from the game.

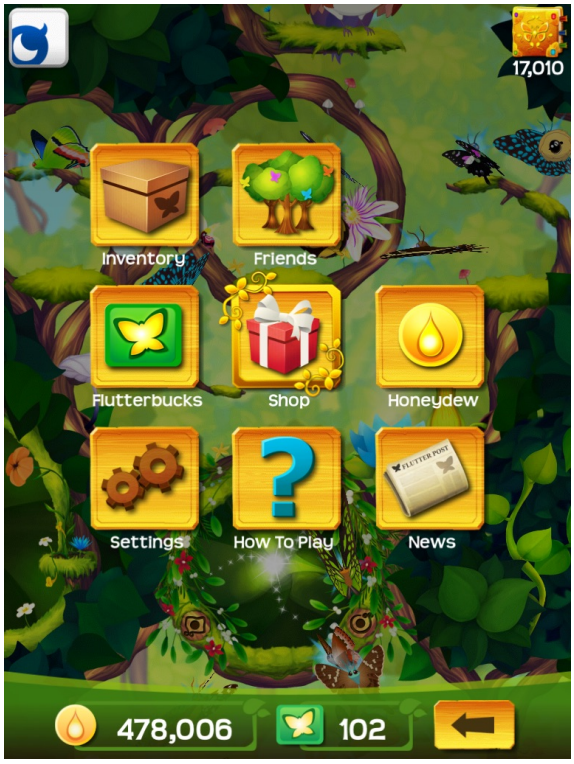


FIGURE 2.9: MAIN MENU SCREEN ELEMENTS

The Main Menu screen provides the player with access to a number of different features including the shop and sharing. The Inventory is the most relevant to later studies, however.
(Copyright Runaway 2015)

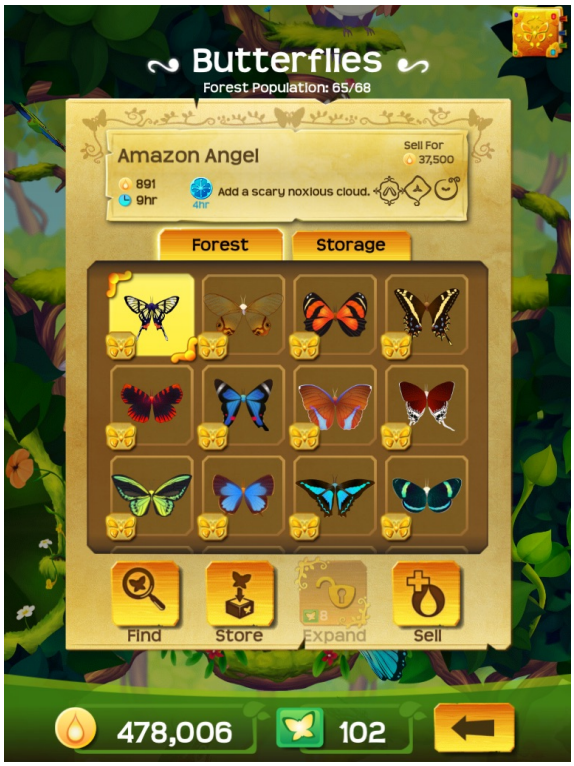


FIGURE 2.10: MAIN MENU INVENTORY SCREEN

Players can swap butterflies to manage their limited "Forest" and "Storage" space. Butterflies in the Forest space are active on the Sanctuary Screen and are used in the Mission System.
(Copyright Runaway 2015)



FIGURE 2.11: MAIN MENU GAME CURRENCIES

Flutterbucks represent a 'hard currency' that can be purchased for US dollar amounts. Honeydew is a 'soft currency' that is collected from butterflies, but can also be purchased with Flutterbucks. (Copyright Runaway 2015)

2.3. Next Steps

While it is difficult to capture the nuances of a play experience in words, this chapter has aimed to provide the most relevant aspects of Flutter to this research. In the following chapter, both the Flutterpedia and Mission System are revisited in order to use the comprehensive player metrics as an assessment of behaviours relating to learning outcomes associated with the factual content in Flutter. This provides a quantitative insight into whether players are learning within an entertainment focused game, and offers perspectives about what players may be gaining from the included factual content. This is combined with qualitative results in Chapter 4 to uncover additional relationships players may be experiencing with factual content, living butterflies, and their interests both inside and outside of the game.

CHAPTER 3: DOES FACTUAL CONTENT IMPACT PLAYER LEARNING?

3.1. Introduction

In Chapter 1, learning was identified as one of the common aspects of engagement between game developers and nature communicators alike, and represents a foundational component of personal interest in a topic (Azevedo, 2011; Falk & Dierking, 2000; Hidi & Renninger, 2006). In this chapter, I'll explore this further by first providing some background on learning within video games, and then by presenting a study aimed at whether or not players seem to be learning from their interactions with Flutter. By leveraging Flutter's quiz-like Mission System, comprehensive player metrics were collected to assess player performance as it relates to recognising and associating butterfly species with the game's factual content. It is expected that if players are learning from engaging with this content, it will be recorded by the metrics associated with the game's Mission System. This will then be used to further determine whether there is a relationship between player learning and interest in the following chapters.

Of course learning in video games is hardly a new area of research. A number of studies have already demonstrated how games can be used to teach concepts to a variety of age groups ranging from young children to college level adults (De Gagne, Oh, Kang, Vorderstrasse, & Johnson, 2013; Orji, Vassileva, & Mandryk, 2013; Ritzhaupt, Poling, Frey, & Johnson, 2014; Shute et al., 2015). While these studies are useful to the over-all dialogue of gaming in education, they are primarily focused on games specifically designed with educational intent. As Shute et al. (2015) and Baniqued et al. (2013) have discussed, entertainment oriented games are rarely the focus of studies on passive learning effects, especially within the casual gaming market. Shute et al. (2015) go on to point out that games developed without a specific learning objective can also produce learning outcomes with players, sometimes even outperforming games with targeted outcomes. Researching the learning affects of games not specifically designed for education represents an apparent gap in gaming literature, and this study aims to contribute

to this gap by taking advantage of Flutter's passive use of factual content within an entertainment oriented setting.

Flutter's combination of factual content and quiz-like mini-game system make it an ideal resource through which to investigate learning within entertainment media. The factual content included in the game is not unlike that found in displays at museums, zoos, or other nature centres. Furthermore, the question and response style of the mission mini-game system functions similarly to pre- and post-test learning evaluations. These types of measures are commonly found within both gaming and education literature, and have been used to assess student learning through games (Annetta, 2008; Barab et al., 2009; Barko & Sadler, 2013; Charsky & Mims, 2008; Connolly et al., 2012; Hwang et al., 2013; Papastergiou, 2009; Ritzhaupt et al., 2014) learning in the elderly (Tong, Chignell, Lam, Tierney, & Lee, 2014), and studies into claims of improved cognitive function through casual gaming (Baniqued et al., 2013; Charsky & Mims, 2008; Cowen & Tesh, 2002; Shute et al., 2015; Tong et al., 2014).

3.2. Methods

3.2.1. RESEARCH QUESTION

The primary research question posed by this study was: are players learning from the factual content presented in Flutter, particularly as it relates to player performance at fact and butterfly recognition related questions. This was investigated using a Spearman correlation to compare player metrics for guesses at mission questions, to how many times the question had been presented before. Calculations were made by the Statistical Package for the Social Sciences (SPSS) software.

3.2.2. CATEGORISING THE FACTUAL CONTENT IN FLUTTER

To better understand what factual content players were being exposed to by the Flutter Mission System, a complete list of the one hundred previously released mission questions were obtained from the Runaway team. These 'old mission' questions were then grouped based on hints written into their text, and are presented as Appendix A. These groups included the recognisable colour and pattern of the butterfly wings, the common name, scientific name, species fact, and butterfly's home region. A number of questions relating non-factual game information were also identified and included in tables A.7 - A.9.

Screens containing answers to mission questions were also located and are presented in Table 3.1. This proved useful when deciding which questions should be included in this study, and helped identify both what content was regularly encountered by players, as well as what would be easier for them lookup when responding to mission questions. The butterfly wing patterns and common names were the most common types of factual content, and were present in the Sanctuary Screen, Inventory, and Flutterpedia. Scientific names, species facts, and the butterflies' home regions were shown to be unique to the Flutterpedia, and therefore required more steps should the player seek to look them up.

TABLE 3.1: FLUTTER SCREENS CONTAINING FACTUAL CONTENT

Butterfly factual content was mapped to different locations within the game in order to identify what was being encountered the most by players, as well as what might be easiest for them to lookup.

Factual Content Type	Sanctuary Screen	Flutterpedia	Inventory Menu
Colour/Pattern	x	x	x
Common Name	x	x	x
Scientific Name		x	
Fact		x	
Region		x	

3.2.3. MISSION SYSTEM MECHANICS

The Flutter Mission System is a mini-game element that works essentially like a quiz, and was central to collecting the metrics that would be used to assess learning. Mission questions are chosen at random based on the butterflies currently displayed on the player's Sanctuary Screen. As mentioned in the previous chapter, the mission question text contains clues to which butterfly, or butterflies, can be used to complete a mission. Players are therefore challenged to identify the correct butterfly wing patterns from all the butterflies currently moving through their Sanctuary. Guesses are recorded when players move one of their butterflies to the answer platform. Once there, the Kingfisher character provides feedback to whether they have it right or not.

It is important to note that there aren't any negative consequences for guessing the wrong butterfly. Additional guesses can be made at any time within a 24-hour period, and answers can be sought within any of the other play screens, including the Flutterpedia. This means that direct memorisation of which butterfly matches each question hint could make the mission process easier for the player, but it is not required. However, since factual content was not organised in any way

conducive of looking-it up, any use of the Flutterpedia would still likely require some memorisation. In particular, mission questions relating to scientific names, regions, and individual facts would not be easily found unless the player had an idea of the specific butterfly, or butterfly set, they were looking for already.

3.2.4. MEASURING LEARNING

Learning was measured through player performance by comparing the number of guesses players made, to how many times they had been shown a mission question before. A SPSS calculated Spearman's coefficient was used to identify any correlation. Unfortunately, individual player progress could not be tracked by mission metrics, and therefore two question sets were used in an attempt triangulate potential learning outcomes. The broadest of the two sets relied on interactions already occurring within the game by taking advantage of the one hundred previously mentioned old questions. Although these had the potential to record interactions with questions seen many times before, they also were the most vulnerable to unknown variables. Therefore ten original questions, later referred to as 'new missions', were written and made available on a controlled release date. These 'new missions' provided a sequential record of player interactions, and serve as a point of comparison to test whether the metrics data being recorded could be linked to learning.

Due to the mechanics of the Missions System, this method also tested whether players were learning to recognise their butterfly species, as answering a mission question also required them to visually identify the correct butterfly from the others in their Sanctuary.

3.2.5. IMPLEMENTING NEW MISSION QUESTIONS

The ten never before seen mission questions were added to Flutter and are detailed in Table 3.2. Care was taken to provide questions that focused on specific types factual content, as well as to target butterfly species that had rarely been used to answer the old missions. This helped reduce the likelihood of players already being familiar with the correct butterfly before being exposed to the question for the first time. Additionally, because these questions were new to the game, metrics data would collect a complete record of player performance within the study period. This meant that while individual player progress could not be

linked to the results, it was being tracked and included as players continued to interact with the question throughout the study.

The ten new mission questions were analysed over a five-week study period starting October 16, 2014 and ending November 23, 2014. Using this starting date allowed for player metrics to record every interaction from the time they were released, to the end of the study. This duration was set at five weeks to allow enough time for a large number of interactions (n = 16,666) to be recorded while the new missions were cycled in along with the 100 old missions.

TABLE 3.2: NEW MISSION QUESTIONS

Ten New Mission questions were written to emphasise certain types of factual content within Flutter, as well as to test players on butterflies not regularly used by the old missions.

missionID	Question Text: New Questions	Primary Content
101	The DELIAS butterflies are ready for a surprise party, can you send the guest?	scientific name
102	PAPILIO THOAS is having a fantastic day and wants to find someone to cheer-up!	scientific name
103	Can you send your POLYRA DELPHIS to do some wing yoga on a leaf?	name/ scientific
104	Yikes! Those caterpillars are trying to EAT EACH OTHER! Is there a butterfly who knows what's going on?	fact
105	Some invasive ants are spreading, can you send a butterfly whose CATERPILLAR grows an anti-ant OSMETERIUM?	fact
106	Is there someone here who can go serve as the "King Spirit" for a MADAGASCAR ceremony at DUSK?	fact
107	Can a WAYANG SWALLOWTAIL go trick some bug eating birds into leaving?	colour/ pattern
108	Your JEWELED NAWAB needs a little time away, let's give it a sunny vacation!	common name
109	Some flowers are blooming in a distant part of the forest, can your CHAMAELIMNAS BRIOLA see what kind they are?	scientific name
110	Do you hear that bird call? Let's see if the BROAD-BANDED DEMON can find out what it is.	common name

3.2.6. WORKING WITH OLD MISSION QUESTIONS

As discussed in Section 3.2.4, the 100 old mission questions were grouped and analysed based on their content and presentation within the game. A number of question groups were then eliminated from the final results as the answer could be accessed directly from the Sanctuary Screen. This was done to avoid a number of false positive resulting from situations where players could confirm the correct

answer on the Sanctuary Screen, without logging any guesses in the metrics. The groups of questions removed involved those relating explicitly to the butterfly's common name (Table A.4, Table A.5), wing colour and pattern (Table A.6), rarity within the game (Table A.7), size (Table A.8), and the butterfly's Set grouping (Table A.9). The remaining 34 questions included in the results related to the butterfly fact text (Table A.1), region (Table A.2), and scientific name (Table A.3).

Data for the old missions were taken over a two-week period between the dates of October 2nd and October 15th, 2014. Within this two-week period, a total of 438,856 interactions were recorded with only 73 linked to game crashes. An additional 334,493 interactions were removed to avoid cases where the mission questions could be answered correctly without guessing. This resulted in the final number of interactions totalling 104,290.

3.2.7. IMPLEMENTING PLAYER METRICS CONDITIONS

As mentioned above, payer metrics did not record individual progress, but instead collected the number of times specific player choices were made each day. These were then divided into one of two defining conditions. The first condition recorded whether a mission had been completed by a player, and the second recorded whether it had been skipped. A "MissionComplete" condition was registered after a player had presented an appropriate butterfly and activated the 'Begin' button in the mission. Instances when the player chose to skip the question, by paying with Flutterbucks or by allowing the question to time-out automatically, were recorded by a second condition called "MissionSkipped". Additional testing procedures for these metrics are included in Appendix C.

3.3. Results and Discussion

3.3.1. ARE PLAYERS LEARNING FROM FLUTTER FACTUAL CONTENT?

The metrics variables used to assess whether players were learning by performing better at fact related questions over time demonstrated moderate and very weak Spearman correlations between the variables. A moderate negative correlation was recorded for the new missions (r_s = -0.059, p < .001, n = 16,666) while the very weak positive correlation was recorded for the old (r_s = 0.014, p < .001, n = 104,290). This was disappointing in that while the moderate results showed a relationship suggestive of basic rote learning, the more robust study seemed to indicate the opposite through a 'very weak' correlation. Although these were significant, a surprising finding was that both studies appeared to be masked by the number of times players got the questions right without registering any guesses. For new missions, this accounted for 15,294 (92%) of the recorded interactions, while for the old missions this percentage was higher at 93% of the total. This suggests that for the vast majority of the results, players were able to answer mission questions correctly on the first try, thus eliminating the possibility for improvement in either question set. Future research might consider ways of associating player IDs with specific results, or add metrics to record how long it takes a players to complete a mission interaction successfully, possibly also recording whether the Flutterpedia or another menu was opened in the process.

Although unexpected, these results have a number of implications, most significantly being that players seemed capable of consistently recognising specific butterfly wing patterns from the number of other species active within their Sanctuary Screen. Additional interpretations may also suggest that players were instinctively searching for the answer before even attempting the question, or conversely that the information had already been committed to memory by the player before the question was ever presented. Regardless of whether players were looking the information up before answering the mission question or not, these results contribute to the findings of Shute et al. (2015) and Baniqued et al. (2013) by suggesting that players are learning to recognise the wing patterns passively within an entertainment oriented game.

Striking more at the root of this analysis, however, it should be acknowledged that engagement through the memorisation of facts has already been identified

within the field of education as a form of shallow cognitive engagement (Bloom, 1956; Harlow et al., 2011). This alone does not make for engaged participants, nor does it necessarily add up to learning. It can be one of the indicators of personal interest (Kiili, 2005), which can lead to more engagement opportunities and practice (Azevedo, 2011; Falk & Dierking, 2000; Liu & Falk, 2014). Therefore, an important question remains in whether players are connecting what they learn from their experiences in Flutter, to the events of their daily lives and the natural world. This becomes the frame of the next chapter, which focuses on the qualitative measures surrounding player interests, and associations with butterflies, in and beyond the gaming environment.

CHAPTER 4: EXPLORING INTEREST THROUGH FLUTTER'S FACTUAL CONTENT

4.1. Introduction

In Chapter 3, I looked for a measure to record what *Flutter: Butterfly Sanctuary* players were learning by engaging with factual content and the Mission System gameplay mechanic. While a measure of learning remained elusive, players were shown to be performing well at tasks relating to visually recognising species within the game. In this chapter, I'll continue our investigations using player attitudes and behaviours through a qualitative online survey. From this, I'll gain insight into the role that factual content has on maintaining player interest in Flutter itself, while exploring its impact on creating interest in real species outside of the game. As was discussed in Chapter 1, interest has been shown to be an important part of engagement for both game developers and nature communicators alike. Hidi and Renniger (2006) describe its value to gaming industry as a driving factor for re-engagement, which can also be linked to deeper learning and meaning-making activities discussed within informal education (Azevedo, 2013; Falk & Dierking, 2000; Liu & Falk, 2014). Interest has also been related to cognitive knowledge and learning (Appleton et al., 2006; Christenson et al., 2012), awareness (Lorenzoni et al., 2007; McCallie et al., 2009), and personal behaviours and feelings (Fredricks et al., 2004; Hazel et al., 2013; Norris et al., 2014). These align well with our broader discussion of engagement, and help to identify the measures used to address the primary research questions of this chapter.

4.2. Methods

4.2.1. RESEARCH QUESTIONS

Eleven survey questions (Table 4.1) were approved by the University of Otago Ethics Committee (Reference Number 14/189) and presented to Flutter players as described in Section 4.2.2. Each survey question from Question 2 to 10 relates to one of the five research topics below, and will be revisited when framing Section 4.3.

1) Do survey participants represent the broader Flutter audience through age, gender, and spending demographics?

2) What role does factual content play in player interest in Flutter?

3) Can surveyed participants differentiate factual from non-factual game elements?

4) Can playing Flutter encourage participants to become more interested in butterflies outside of the game?

5) Is Flutter reaching audiences who may not have access to real butterflies?

The survey itself was administered through the online service Typeform, which was chosen for its superior performance on mobile devices and in relation to the game. To see how the questions were presented in Typeform, please refer to the grouped figures in Appendix C. Results were exported to Excel and SPSS for analysis, and a Kruskal-Wallis Test was applied to find relationships between a number of the questions. Because the research questions involved a number of tests comparing questions, only the relevant findings will discussed in the following sections, while more complete results will be presented in Appendix D to Appendix G. Spreadsheets of raw data are available through the Centre for Science Communication at Otago University.

TABLE 4.1: FLUTTER SURVEY QUESTIONS

Ten online survey questions were presented in Typeform to provide demographic comparisons, assess participant interest in factual content, assess participant interest in butterflies beyond Flutter, and address participant access to living butterflies.

Question #	Survey Question	Survey Intention
1	In taking this survey, I acknowledge that I have read the Information Sheet, and have no further questions about this project.	Consent to participate
2	To which AGE GROUP do you belong?	Demographic comparison (age)
3	Does either Flutter's gameplay or factual content hold more interest for you?	Participant interest in factual content.
4	What Flutter content do you believe to be factually correct?	Participant identification of factual content.
5	How important is factual content to you when making a Flutter in-game purchase?	Participant interest in factual content in relation to value.
6	Which best describes your interest in butterflies?	Past interest in butterflies outside Flutter.
7	Where do you regularly see living butterflies?	Access to living butterflies.
8	Has playing Flutter made you more aware of butterflies outside the game?	Participant extended interest in butterflies through awareness.
9	How likely are you to lookup more information about the butterflies you discover in Flutter?	Participant extended interest in butterflies through personal discovery and behaviour change.
10	Who do you share your Flutter butterfly discoveries with?	Participant interest in factual content through social connections.
11	With which gender do you identify?	Demographics comparison (gender)

In addition to the responses from the survey, website and player metrics were recorded when players accessed the survey. Player metrics involved a user identification number (userID), and the amount of Flutterbucks (hard currency), converted to US dollars, that a player had purchased over their lifetime within the game. Google Analytics were used to obtain website metrics that tracked geographic locations, cities and/or towns, from which participants accessed the survey. These results, along with responses from Question 7 (Table 4.1), will be briefly addressed in the final section of this chapter, Section 4.3.5.

4.2.2. RECRUITING, EXCLUSIONS, AND 'THANKS'

Participant recruitment occurred through social media channels and in-game advertisements. Any players interacting with the Flutter Facebook Page, Runaway blog, or Flutter game itself between the dates of November 6th and November 10th, 2014, were exposed to the survey. Dates were chosen so as not to coincide with any other game events, which could detract from participation. Participants accessed the survey from a link within the Flutter game. A consent form was made available on the Runaway public blog through an online link, an example of this sheet is included in Appendix D. Because parental consent could not be obtained, participants identifying themselves as under 13 were not exposed to any remaining questions, however their age was preserved for demographic comparisons. The survey questions were considered to be low risk to other age groups by the University of Otago Ethics Committee, and were therefore included in the results.

A total of 23,235 unique participant responses were recorded between November 6th and November 10th, 2014. This number was reduced to account for age restrictions and unidentifiable userIDs. An additional 1,103 were identified as under the age of 13, and were not included in this total. A further 2,516 of the responses were also not included as their authenticity could not be verified, either due to duplicate or unregistered userID numbers.

Finally, a 'thank you' bonus of ten Flutterbucks, equivalent to $0.04 USD, was advertised and applied to individual accounts of anyone competing the survey. To protect privacy, care was taken to separate userIDs from the survey responses before being sent to the team at Runaway. This protected privacy by preventing Runaway team members from being able to connect individuals to responses, as required by the University of Otago ethics approval, and assured that player profile information was not being made available outside of the Runaway development team.

4.2.3. PARTICIPANT-TO-PLAYER DEMOGRAPHIC COMPARISONS

To determine whether the surveyed participants were representative of the broader Flutter gaming population, demographic data relating to age, gender, and game spending of surveyed participants were compared to averages obtained from the Flutter Facebook Page. These averages represented the most complete metrics that could be obtained from Runaway, and are estimated to reflect approximately 52% of the total playing population. Although these averages were more robust than the survey participant results, players under 13 were automatically excluded from the Facebook data, along with any player choosing not to connect their Flutter game to their Facebook account. Additionally, averages were used as instead of exact daily values as the player base continually changes from moment to moment as people choose to add and remove themselves from the game.

4.2.4. MEASURING INTEREST AND IDENTIFICATION OF FLUTTER FACTUAL CONTENT

Questions 3, 4, 5, and 10, were used to assess participant interest in factual content through feelings and behaviours associated with the game experience. Spending and sharing were both considered to be important behavioural measures, and a number of Kruskal-Wallis tests were performed to identify significant relationships between the different responses. Relevant findings will be discussed in the following section, but the test results are included in the tables of Appendix E and Appendix F. Questions 3 and Question 5 recorded whether participants would self-report interest in factual content, with Question 3 asking participants to rank their interest on a scale with gameplay and factual content. Question 5 measured the value of factual content to participants by recording its perceived influence on purchasing decisions. This was compared with actual spending metrics recorded by the survey, and used to further evaluate the perceived value of factual content to different spending groups. Sharing behaviours were measured by Question 10 in relation to how many participants reported not sharing with anyone, instead of the other options.

Question 4 focused on the content that participants believed to be factually correct, and was used to determine whether or not players were consistently able to separate factual from non-factual game elements. Selections for this question included four factually researched game elements, and four non-factual

components added for gameplay and design purposes. The factual elements identified for this study were the butterfly wing patterns, relative butterfly sizes within a set of butterflies, as well as the frog and bird game characters. Non-factual elements included the shape and colour of caterpillars; the Attraction Flowers, used to attract new butterflies; the imaginary forest Wisp Mother character; and the relative size of all the butterflies outside a set. Section 2.1.3 describes each of these elements further, with additional reference images depicting each.

4.2.5. MEASURING INTEREST AND ACCESS TO LIVING BUTTERFLIES BEYOND FLUTTER

Questions 6, 7, 8, and 9 represented questions relating to player interest in butterflies, and were used to identify whether interest was extending beyond the game through behaviours and associations with real butterflies. Behavioural measures included reported awareness of butterflies, as well as the likelihood of looking up more information. A number of Kruskal-Wallis tests were performed to identify significant relationships, and are presented in full in Appendix G. Since it was anticipated that players with a strong prior interest in butterflies would likely be drawn to a game about butterflies, Question 6 was added to identify and compare respondents with more or less prior engagement with butterflies. Notably, groups expressing no interest in butterflies, a life-long interest in butterflies, and those associating their interest with playing Flutter were of great interest. Unfortunately overlapping timescales written into the question resulted in a small percentage of responses with ambiguous time scales (11%). These were kept separate, to reflect how they were presented to participants, but as such could not be clearly used in the following Results and Discussion section.

4.3. Results and Discussion

This survey aimed to investigate whether the inclusion of factual content within the casual game Flutter was being valued within the game itself, as well as potentially generating interest in butterflies beyond the game. Results proved encouraging, and are supported by strong comparative demographics that confirm similarities between the surveyed participants, and the larger Flutter population. While the overall results seem encouraging, a number of interesting relationships were revealed which prove relevant to discussions in both this and the following chapter.

While it can be suggested that the surveyed participants were interested in the factual content, results described later in Section 4.3.3 also suggested that participants were largely unable to consistently distinguish factual content from the non-factual elements. Additional results were also found to support the idea that Flutter may have a role in extending player interest in butterflies beyond the game. This seemed most effective on participants already exhibiting some degree of prior interest, with mixed results for participants who reported their interest in butterflies as stemming from Flutter, and no change for participants expressing no interest in butterflies. Additional, tests revealed that the group associating their interest in butterflies with Flutter were less likely to 'fact check' information outside of the game. This became increasingly significant in light of the other interest and knowledge related findings. These implications will be further discussed within the next chapter, which will combine the findings from both the metrics and survey studies to identify possible outcomes, roles, and ways forward for game developers and nature communicators alike.

4.3.1. DO SURVEY PARTICIPANTS REPRESENT THE BROADER FLUTTER AUDIENCE THROUGH AGE, GENDER, AND SPENDING DEMOGRAPHICS?

Survey results pertaining to age, gender, and spending demographics suggest the sample of participants to be a good representation of the broader Flutter gaming audience on these points. This is supported by comparing the Facebook and Runaway metrics data to the percentages of surveyed participants recorded in the results, as is presented in Figure 4.1 and Figure 4.2. In each case, the survey data mirrored the broader population data within a few percentage points. This is significant in that these results did not reveal any obviously underrepresented groups between the sample and what is known about the greater playing population. Despite this, it is acknowledged that these results do not preclude other self-selection biases, and are limited in comparisons with the estimated 52% of the Flutter playing population.

Specific numbers relating to in-game spending could not be revealed, however a comparative proportion of free- versus paying-players were confirmed by the Runaway team. These include an expectedly large number of non-paying participants (70%) to the remaining paying players (30%). Additionally Runway reported that especially dedicated players may spend upwards of $700.00 in

they're playing lifetime. These extremely high spending players make-up less than one-percent of the total gaming population. A number of players showing these very high spending patterns were identified within the survey results, but were too few to report on separately, and have instead been included in high spending group for analyses.

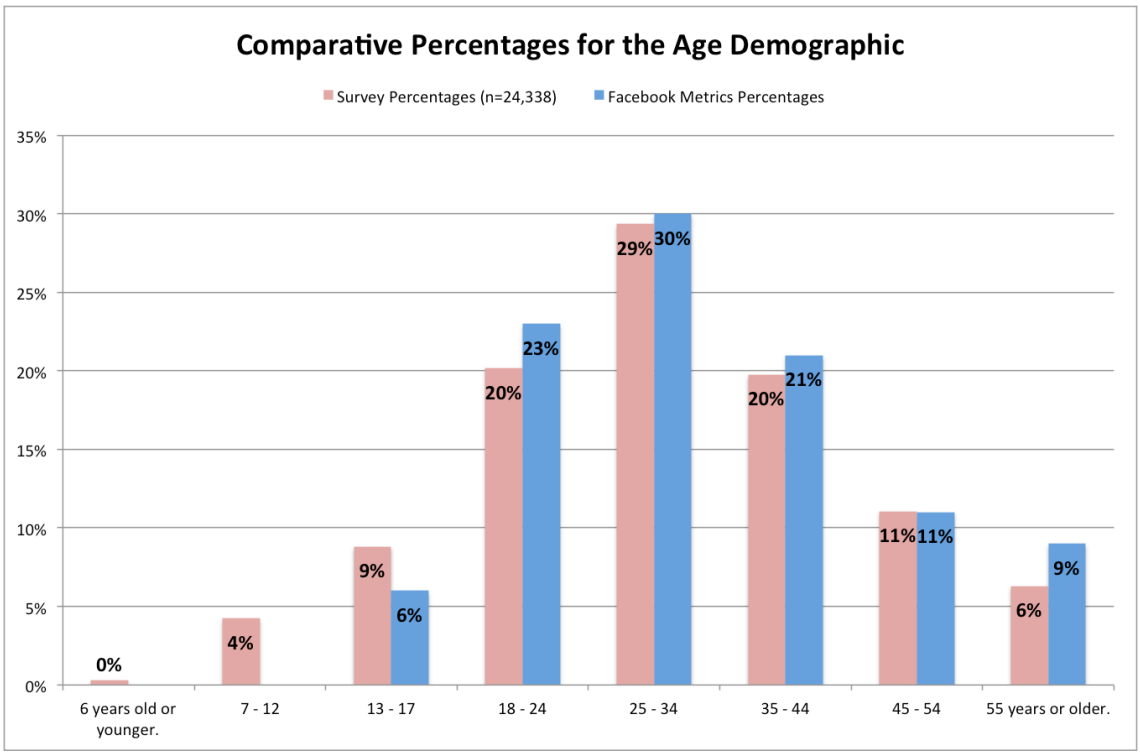


FIGURE 4.1: COMPARISON OF AGE DEMOGRAPHICS

Survey results for age recorded similar percentages to the averages obtained from Flutter Facebook Page metrics.

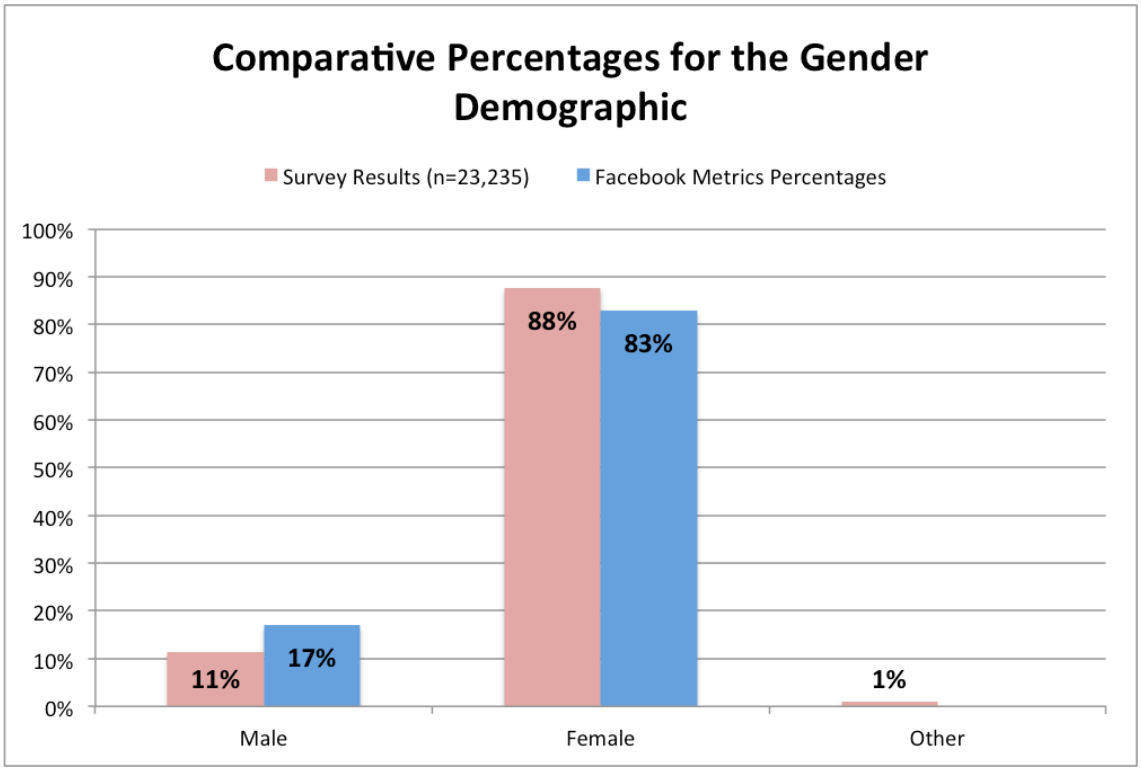


FIGURE 4.2: COMPARISON OF GENDER DEMOGRAPHICS

Survey results for gender recorded similar percentages to the averages obtained from Flutter Facebook Page metrics.

4.3.2. WHAT ROLE DOES FACTUAL CONTENT PLAY IN PARTICIPANT INTEREST IN FLUTTER?

Questions recording participant interest in factual content are presented as percentages of the population (n=23,235) in Figures 4.3 and 4.4, and analysed through a number of Kruskal-Wallis tests presented in Appendix E. The results of Question 3 do not reveal an explicit preference for gameplay elements or factual content (Fig. 4.3).

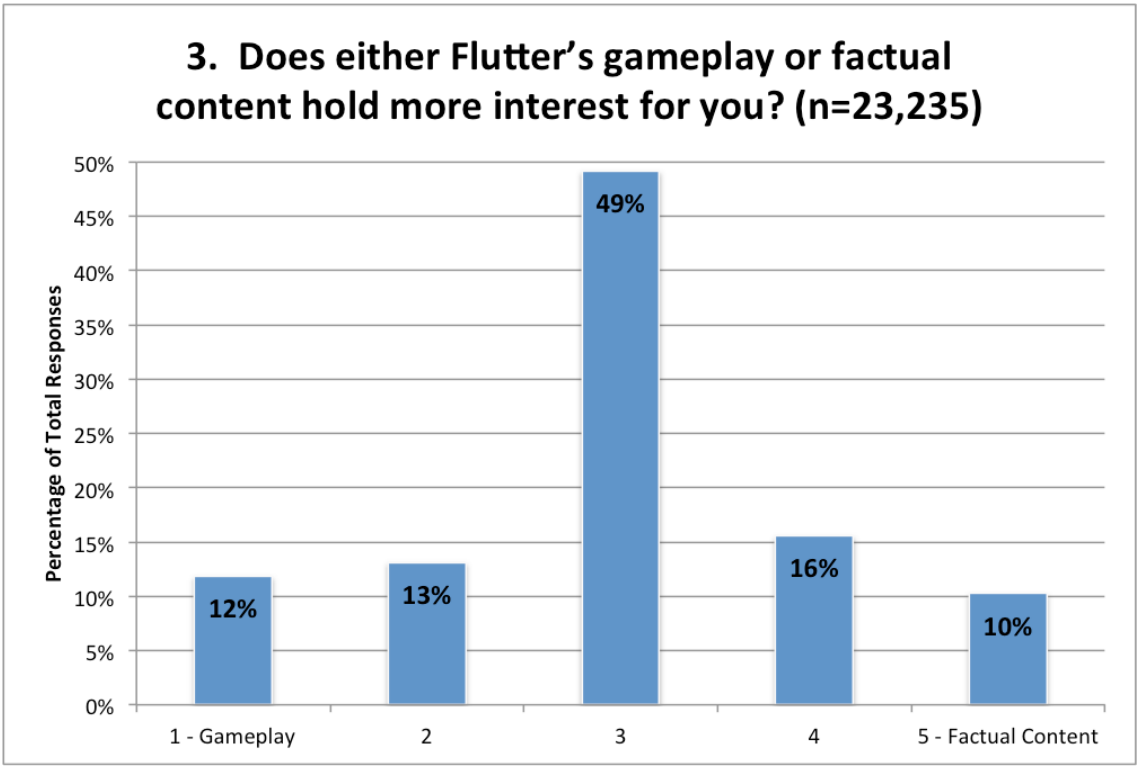


FIGURE 4.3: INTEREST IN FLUTTER FACTUAL CONTENT (QUESTION 3)

Survey results for Question 3 do not reveal a stronger interest in gameplay or factual content.

Results pertaining to interest in factual content are varied, but generally reveal participants to be interested in the factual content included in Flutter through sharing and spending behaviours. This is perhaps best supported by results indicating that up to 78% of the participants were choosing to share their Flutter discoveries (Figure 4.4). A Kruskal-Wallis test revealed statistically significant findings suggesting that participants who expressed a preference for factual content, also tended to share their discoveries more than those with a preference for gameplay. These results can be found in Table E.3 of Appendix E. This supports the idea that factual content is an important part of participant engagement with Flutter and relates to social and behavioural factors that could have potential impact on sharing and marketing.

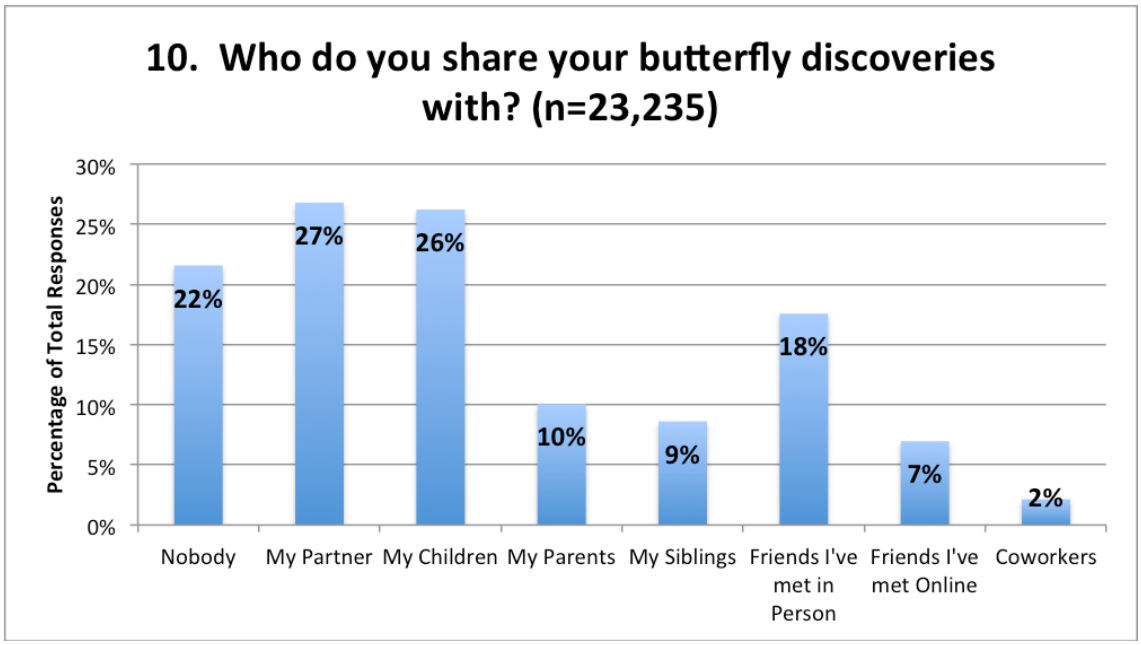


FIGURE 4.4: INTEREST THROUGH SHARING (QUESTION 10)

Approximately 78% of the surveyed participants reported sharing their butterfly discoveries with someone. Roughly a quarter of which were shown to be sharing with their partners (27%) or children (26%). Friends met in person also equated for roughly one-third of the responses (18%).

Tests investigating participant interest through spending behaviours proved less clearly defined. Participant rankings for Question 5 were compared to high-, low-, and non-spending groups and are presented in Figure 4.5. A Kruskal-Wallis Test, included in Appendix E, revealed a statistically significant difference in rankings for the importance of factual content when making purchases across the three different spending levels (Gp1, n=126: high spending participants, Gp2, n=6,839: low spending participants, Gp3, n=16,270: non-spending participants), $x^2(2, n=23,235) = 11.5$, $p=0.003$. The high spending group recorded a higher mean rank (MR = 12,187) than the other two, while the non-spending group ranked higher (MR = 11,705) than the low spending group (MR = 11,400). This seems surprising as one might expect the rankings to remain in order, but instead suggests that factual content is perceived most valuable to the high and non-spending groups, but less so to the low. Additional analyses included in Appendix E supported that participants who identified more positively with factual content, or butterflies, seemed also be spending more than other groups, but did not offer additional clarity for Low-spending participants.

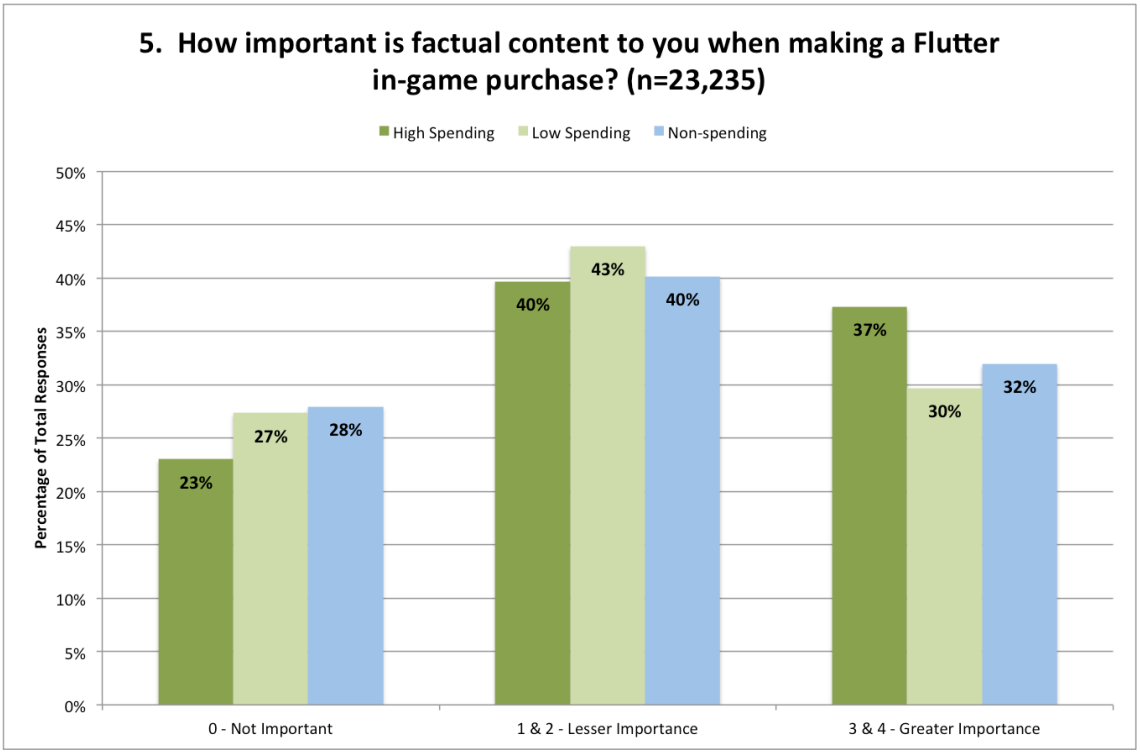


FIGURE 4.5: THE IMPORTANCE OF FACTUAL CONTENT TO SPENDING

High spending participants generally identified factual content to be of greater importance to their purchasing decisions than low and non-spending participants. This was confirmed to be statistically significant by a Kruskal-Wallis test.

Although extending beyond the intention of this study, the relative position of these three groups raises questions of which carries greater over-all value to the game. On-the-one-hand, high spending participants could be associated with generating the greatest amount of revenue, while low- and non-spending players represent the majority of people playing a casual game. These groups may be of greater importance for advertising positions in game stores, and organic marketing of the game through sharing. Unfortunately, no further clarity was gained through the comparison of spending ranks to responses recorded by Question 3. A Kruskal-Wallis test did not reveal a statistically significant difference in participant preference for gameplay or factual content across the different spending levels (Table E.1). This is likely either due to the participants being unable to separate the idea of factual content from Flutter's gameplay, or over confusions of what the factual content in Flutter actually is. Issues surrounding the identification of factual content within the game will be addressed in the next section. Future research would benefit from separating "gameplay" and "factual content" elements into their separate components such as 'artistic design' or 'scientific names', each with their own interest scales.

4.3.3. ARE PARTICIPANTS ABLE TO CONSISTENTLY DISTINGUISH FACTUAL CONTENT FROM OTHER ELEMENTS IN FLUTTER?

While the previous section demonstrated that surveyed participants were interested in the factual content included in Flutter, the results of Question 4 suggest that they were unable to consistently distinguish factual from non-factual elements. This is illustrated in Figure 4.6, and is of potential concern given the number of participants shown to be sharing their discoveries (78%), as revealed in the previous section. Three Kruskal-Wallis Tests were was performed on three of the responses and further revealed that even when participants were correct, they were inconsistent. Of these three tests, wing patterns and the wisp character were chosen to represent content participants ranked as the most and least factual. A test was also run using the frog character in order to gain perspective on a lowly ranked but truly factual element. Values for these tests are included in Appendix F.

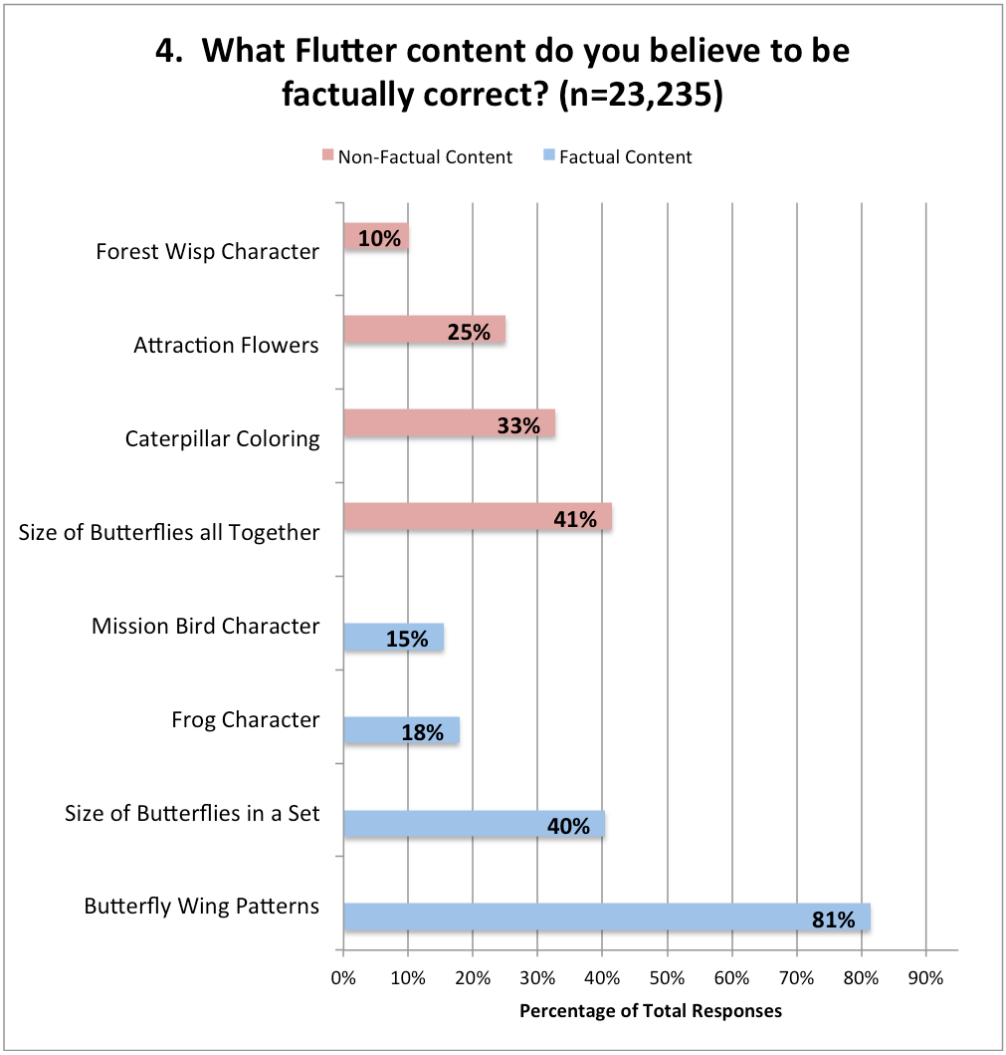


FIGURE 4.6: IDENTIFICATION OF FLUTTER FACTUAL CONTENT (QUESTION 4)

Results to Question 4, when grouped by factual content (blue) and non-factual content (red), show inconsistencies in what players distinguish as factual and non-factual content.

The apparent confusion over the factual and non-factual elements suggest the need for clearer delineations between factual and non-factual elements within a mixed factual game setting. These features are noted from responses to the Bird, Frog, Wisp, and Caterpillar designs. Care should be taken when extrapolating these results, however, as a number of discussions have revealed potential problems with the wording of the question itself. For example, players may not have sufficiently understood the difference between the non-factual "Attraction Flowers" and the factual "Decorations" (which were not included in the question). Discussions have also revealed confusion over the word "character" when referring to the Wisp, Frog, and Bird, which could also had an impact on how players chose to respond. While these elements do not completely undermine the results, they do illustrate potential issues that should be taken into account by future studies.

4.3.4. CAN PLAYING FLUTTER ENCOURAGE PARTICIPANTS TO BECOME MORE INTERESTED IN BUTTERFLIES OUTSIDE OF THE GAME?

Responses were recorded for each of the three questions relating to extending interest in butterflies beyond the game, and are represented as percentages in figures 4.7-4.9. Results were generally encouraging, suggesting that a majority of the participants identified with becoming more aware of butterflies (93%) outside of Flutter, and more likely to look up information about them (91%). This is supported through a Kruskal-Wallis test that revealed a significant relationship between the two questions, and is detailed in Appendix G. Further tests revealed that these findings were most true of participants already showing some degree of interest in butterflies, while individuals expressing no interest at all tended not to report any external engagement associated with Flutter. This was demonstrated through tests of participant interest in butterflies to both their likelihood of looking-up more information, and their self-reported awareness of butterflies outside the game.

These tests, presented as Table G.2 and Table G.3, also revealed two other interesting relationships between the life-long interest group and the Flutter associated interest group. The first was that while the life-long interest group was more likely to lookup information outside of the game, they tended to report lower awareness as a result of playing Flutter. This is likely the result of their already high awareness levels. The second, however, revealed that the Flutter associated

interest group were more likely to report increased awareness, but less likely to lookup more information. In essence, this group was less likely to 'fact-check' what they felt they were learning from Flutter, and becomes significant in light of the previous studies in this chapter. This could mean that participants who are becoming more interest in butterflies because of Flutter, may also be more susceptible to being misled by the design choices included within the game.

It should be noted that results relating to prior interest in butterflies suffered from a small percentage of responses (11%) relating to overlapping time periods written into the question. While this may have caused some confusion several mutually exclusive groups were identified proven to be significant (Appendix H). These included the number of individuals expressing a life-long interest in butterflies (50%), a small number expressing no interest (9%), and a moderate number expressing interest derived from playing Flutter (30%). The overlapping groups were included in the final results, presented in Appendix H, but could not be reconciled with the other results, and were therefore largely ignored. Future studies may benefit more from 'recent' and 'long-term' interest options, or at least by providing mutually exclusive response groupings.

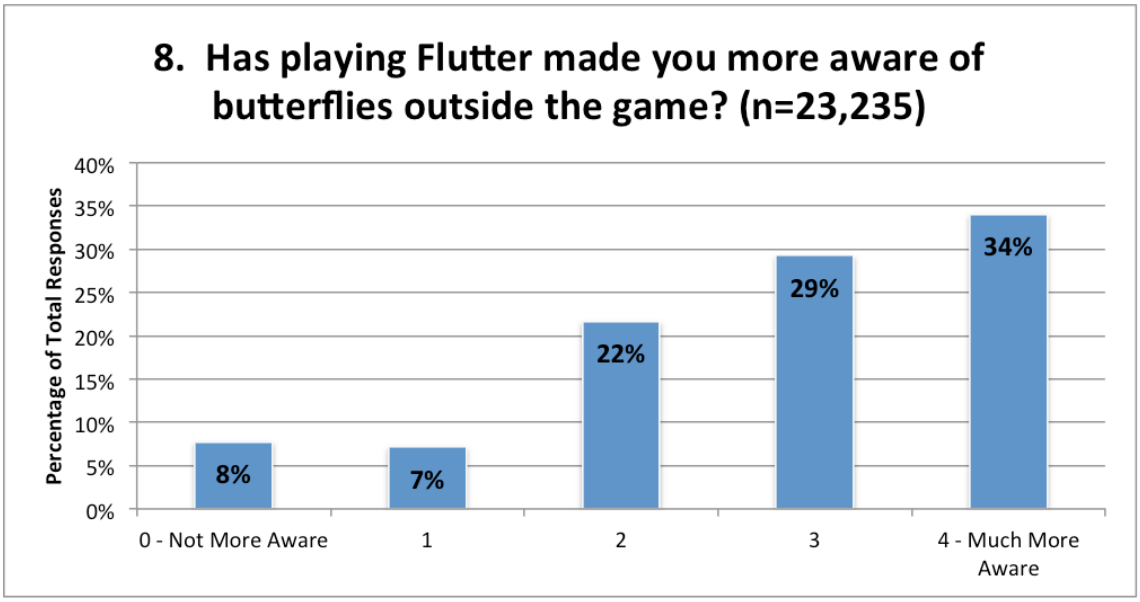


FIGURE 4.7: INTEREST THROUGH AWARENESS BEYOND FLUTTER (QUESTION 7)

A majority of surveyed participants (92%) reported being made more aware of real butterflies because of Flutter.

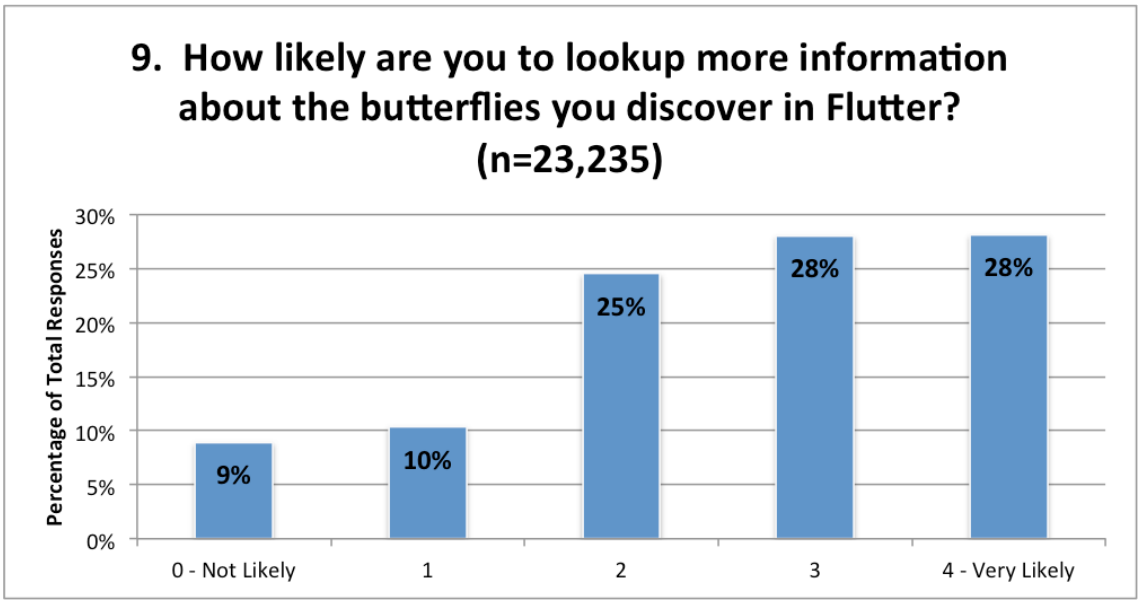


FIGURE 4.8: INTEREST THROUGH VOLUNTARY SEARCHES (QUESTION 8)

A majority of surveyed participants (91%) reported interest in learning more about butterflies beyond Flutter.

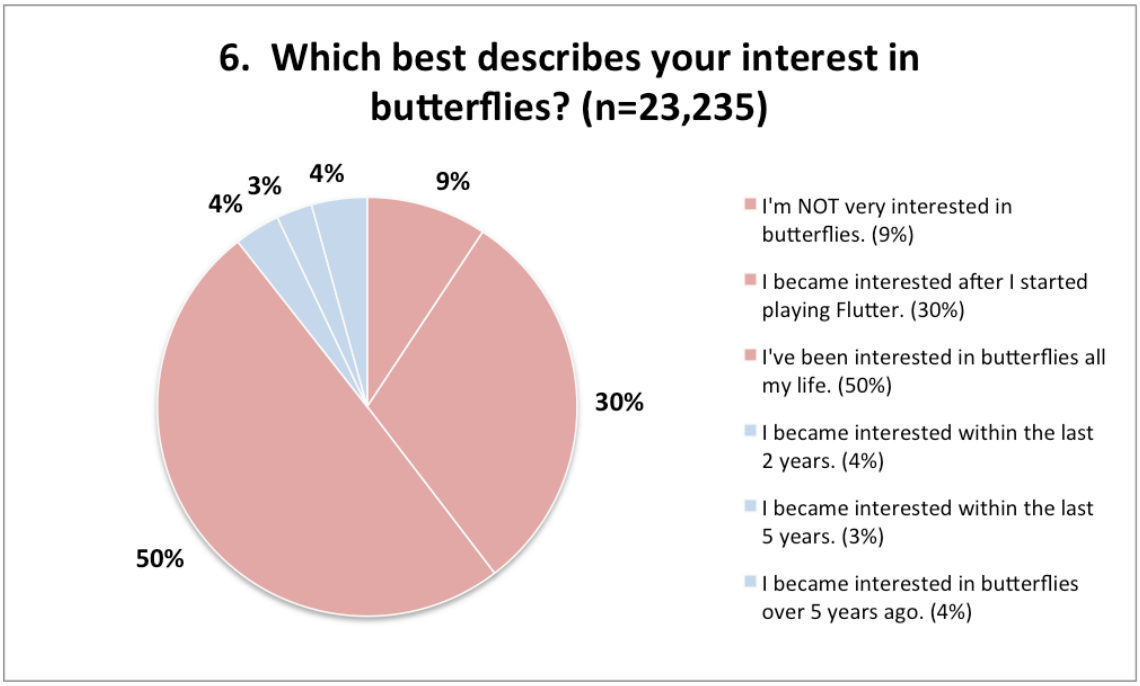


FIGURE 4.9: INTEREST IN BUTTERFLIES

Results for Question 6 identified three useful groups from the survey data: participants with a life-long interest in butterflies (50%), participants who associate their interest in butterflies with Flutter (30%), and participants with no interest in butterflies (9%).

4.3.5. IS FLUTTER REACHING AUDIENCES WHO MAY NOT HAVE ACCESS TO REAL BUTTERFLIES?

The results for participant access to butterflies proved less insightful than originally hoped, but generally suggested that a majority of players (84%) have access to butterflies. This is best depicted in Figure 4.10, which shows a rather low percentage (16%) of participants reporting that they do not regularly see living butterflies. Furthermore, of the places butterflies were most often viewed, participants' homes (52%), local gardens (42%), and Wilderness Areas appeared to be the most popular over other areas such as Butterfly Enclosures (19%), Farms (6%), or Classrooms (2%).

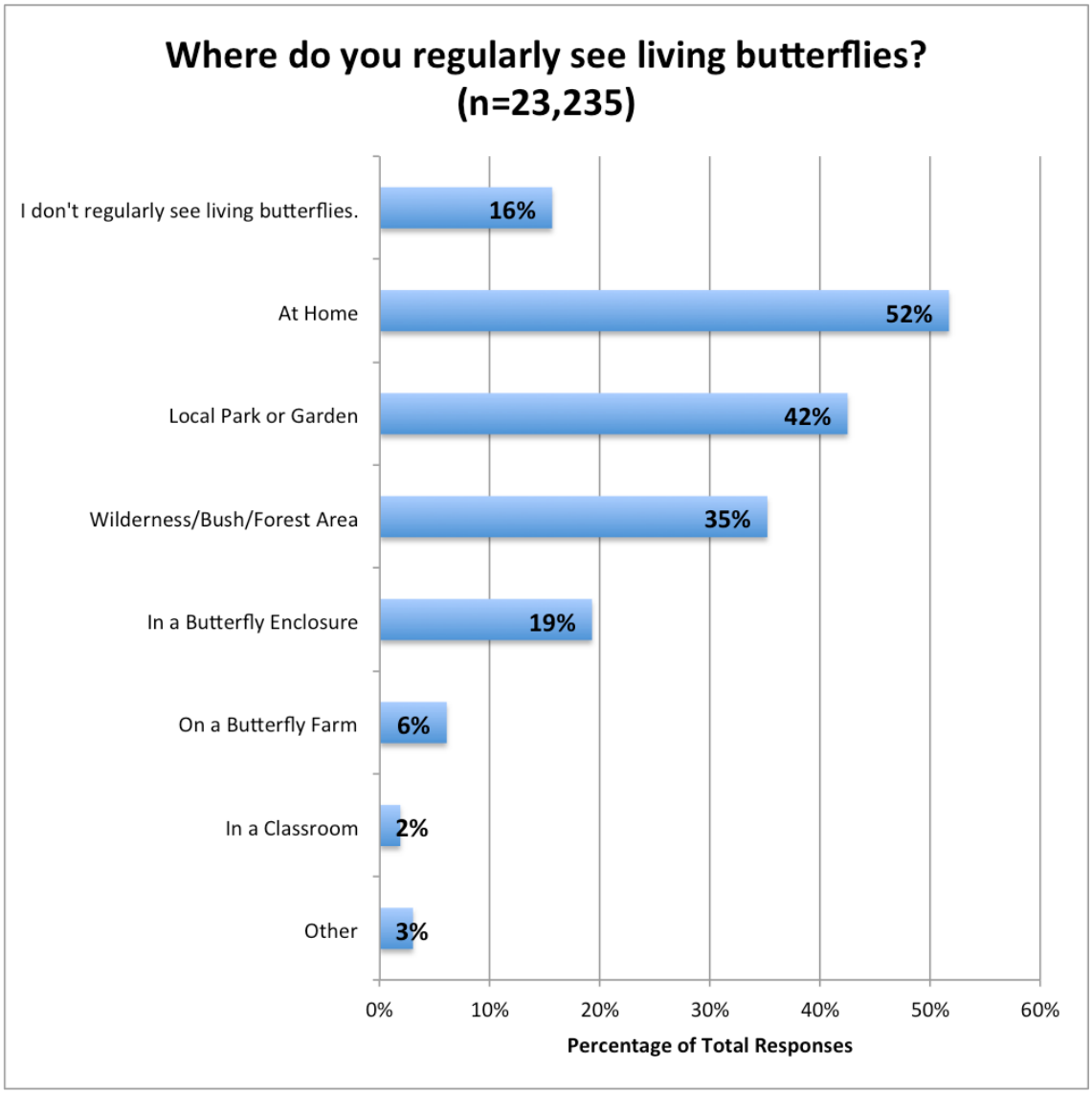
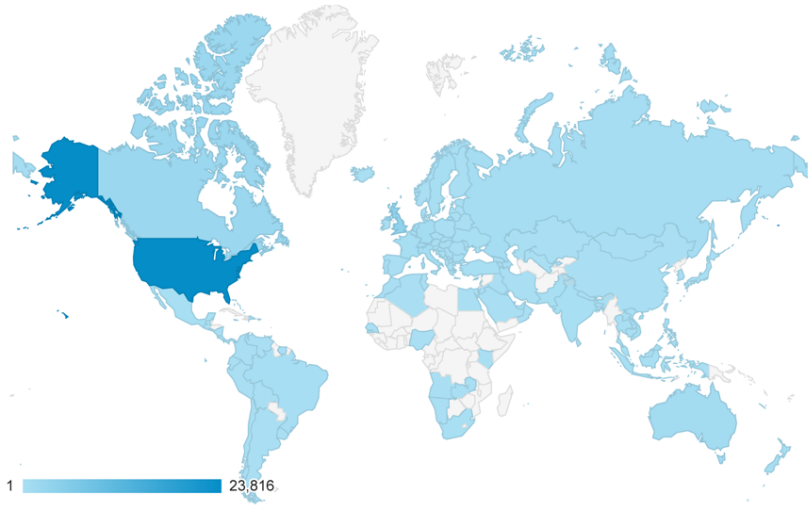


FIGURE 4.10: ACCESS LOCATIONS OF LIVING BUTTERFLIES (QUESTION 7)

Results of Question 7 suggest that over 75% of participants regularly see living butterflies, with "At Home" and "Local Park or Garden" being the two most common locations.

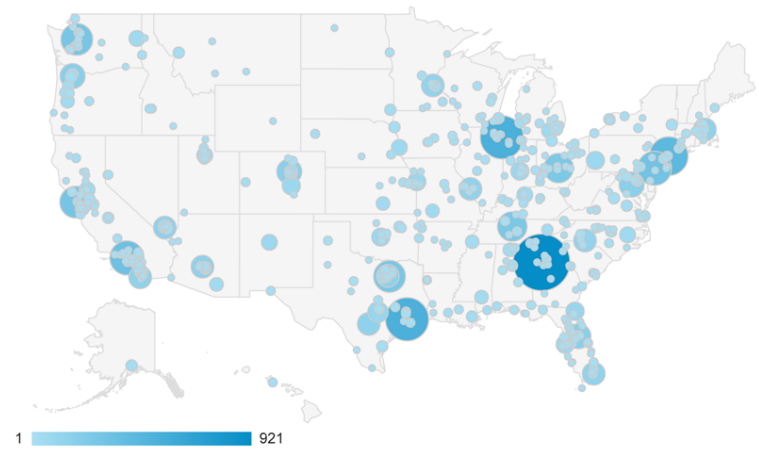
Additional website metrics, collected independently by Google Analytics, recorded 39,344 individual visits to the survey page. Discrete logins were shown to originate from 134 different countries, with approximately 60% of this total originating from within the United States. This was over five-times that of the next most represented country, the UK (Fig. 4.11). It was hoped that a breakdown of the top fifteen US login sites would reveal patterns that might highlight urban areas. While this was possibly observed that California, New York and Texas, which received the highest localised numbers, an equally large proportion of the activity was scattered across rural areas of the country as well (Fig. 4.12). This masked any conclusions about urban vs. rural setting, which was further complicated since these numbers cannot be attached to individual survey results. A future study may wish to record a login location with each of the results instead of relying on independent Google Analytics methods. Additional suggestions for further research will be discussed in the following Chapter, where I'll also be presenting the relevance of both studies to game developers and nature communicators.



	Country	Sessions
		39,344 % of Total: 100.00% (39,344)
1.	United States	23,816 (60.53%)
2.	United Kingdom	3,573 (9.08%)
3.	Canada	2,227 (5.66%)
4.	Australia	1,056 (2.68%)
5.	Germany	851 (2.16%)
6.	Netherlands	721 (1.83%)
7.	Italy	660 (1.68%)
8.	Russia	549 (1.40%)
9.	Sweden	392 (1.00%)
10.	France	367 (0.93%)
11.	New Zealand	333 (0.85%)
12.	Denmark	320 (0.81%)
13.	Brazil	247 (0.63%)
14.	Norway	211 (0.54%)
15.	Belgium	199 (0.51%)

FIGURE 4.11: TOP 15 PARTICIPANT COUNTRIES AND GLOBAL RESULTS

Website metrics show that players accessed the survey from all over the world, but that the US accounted for about 60% of the total.



City	Sessions
	23,816 % of Total: 60.53% (39,344)
1. Atlanta	**921** (3.87%)
2. Chicago	**528** (2.22%)
3. Houston	**524** (2.20%)
4. New York	**423** (1.78%)
5. Los Angeles	**338** (1.42%)
6. Philadelphia	**314** (1.32%)
7. San Francisco	**288** (1.21%)
8. Seattle	**278** (1.17%)
9. Dallas	**266** (1.12%)
10. Nashville	**263** (1.10%)
11. Columbus	**257** (1.08%)
12. Portland	**183** (0.77%)
13. Orlando	**182** (0.76%)
14. Washington	**177** (0.74%)
15. Denver	**175** (0.73%)

FIGURE 4.11: TOP 15 PARTICIPATING CITIES AND NATIONAL RESULTS

Survey website metrics show the top fifteen access areas in the US as being in urban centres, but also that there were many local access points recorded from across the country.

CHAPTER 5: CONCLUSIONS

5.1. Summary

At the beginning of this thesis, I set out to investigate the potential role that popular free-to-play gaming technology may have when engaging young adult audiences with natural world content. I suggested that the goals of game developers and nature communicators may complement one another through the concept of engagement using the shared lenses of learning and interest. I then conducted a number of analyses using the casual free-to-play game *Flutter: Butterfly Sanctuary*. Flutter's commercial success within the entertainment market, inclusion of factual content, and young adult target audience made it an ideal case study for collecting metrics data as well as survey results. In the following sections, I summarise the key findings of this thesis, discuss the significance of the results for game developers and nature communicators, and suggest areas for further research.

5.1.1. SUMMARY OF KEY FINDINGS

In-game metrics produce large amounts of data e.g. n=23,235 in Chapter 3. With further study, these data may be used to assess learning through behavioural measures. These results revealed that players were consistently and accurately differentiating butterfly species visually up to 92% of the time in a situation where the factual target was tied very closely to a practiced gameplay element within Flutter. Survey results indicated that this ability to identify species in the game extended to awareness of living butterflies, with a vast majority of players (92%) reporting an increased awareness of butterflies outside the game.

Survey results also raised some alarms in that Flutter participants were unable to consistently distinguish which game elements were factual and which were non-factual. This was particularly significant in that 30% of participants who attributed their interest in butterflies to Flutter, reported less interest in 'fact-checking' information than other groups. Additionally, 54% of Flutter participants expressed a life-long prior interest in butterflies and 9% were not interested in butterflies. The remaining 11% fell into one of three remaining question categories. Unfortunately these were not able to be clearly analysed because the

periods presented to the participants were neither discrete enough to represent a clear delineation between responses, nor overlapped exclusively with any of the other groups to be considered as a subset. Therefore these data were removed from the analysis.

Player interest in factual content was significantly associated with both spending and sharing behaviours. These associations were most notable in the high spending (1%) and non-spending groups (70%), which represent those contributing most to revenue and word-of-mouth marketing through Flutter community sharing. It was not clear why low spending players (29%) tended to be less interested in factual content than the other groups. Finally, a large number of players reported sharing their discoveries (78%), which was observed to most commonly occur within close family and friend groups, as opposed to within work or online friend networks.

A majority of players (84%) reported having access to living butterflies. The three most commonly reported places for encountering butterflies were at home, in local gardens, or wilderness areas respectively. These were more commonly reported than other options including butterfly enclosures, classrooms, and butterfly farms.

5.2. Relevance to Game Developers

Perhaps the most relevant findings for casual game developers stem from the apparent value and interest players expressed towards the factual content in Flutter. Survey results from Chapter 4 revealed that players are engaging both financially and socially with this content. This suggests that the idea of factual content, at the very least, is playing a role in generating revenue and encouraging word-of-mouth marketing through sharing. Choosing to include factual elements may also be giving Flutter opportunities to engage its audience on a deeper levels. Through a museum lens, Falk and Dierking (2000, p. 113) point-out that meaning-making is one of the dominant motivations for us as human beings. This is not dissimilar to the writings of Jane McGonigal (2011) who encourages game developers to consider ways in which games can connect with and improve people's daily lives. By consistently including recognisable wing patterns, Flutter may be offering its players something more transcendent than good game design.

As was revealed through metrics data in Chapter 3, Flutter players seemed to perform well at recognising species, something that is transferable to their daily lives. That sense of real world skill development may be helping to extend the lifetime value of the player, feeding back into spending and sharing behaviours, as well as potentially driving the high retention that Runaway continues to report. From these findings, I would suggest that developers consider what factual content can be applied consistently, and in a way that is clearly transferable to the target audiences' daily experiences or interests. More studies would be needed to address this kind of meaning-making specifically, but at the very least, it would appear that nature related factual content has a role to play in attracting highly engaged players to free-to-play casual games.

Of course, the opportunities offered by introducing nature themes or factual content into a game were also shown to come with a degree of responsibility. Results of Chapter 4 revealed that it wasn't always clear to players which content was being presented factually and which was not. This adds to the findings of Appel and Maleckar (2012) who observed participants having difficulty differentiating fact and fictional elements in other entertainment media such as film and literature (Appel & Malečkar, 2012). Together, these hint at the need for a clear differentiation between the "real" and design related elements included in the game, with consideration given to how they are presented within the game's structure. This likely does not mean that fact and fictional elements need to be separated or always faithfully represented. Root-bernstein et al. (2013) have already pointed out the role that stylised anthropomorphic characters, stories, and behaviours have in reaching different people and audiences. Instead, I propose that if players aren't able to differentiate content in a mixed setting like a game, then developers need to consider whether they are matching the factual gameplay elements to player expectations. If they don't, or if players become confused about what they can and cannot take with them outside of the game, all the benefits of using factual content may be lost. Therefore, I suggest that developers looking to include factual elements of any kind should consider how those elements fit into the core mechanic early on, by identifying the possible expectations of the player, as well as how the content will serve to engage or add meaning for the player both inside and outside of the game itself.

5.3. Relevance to Nature Communicators

Results of this study suggest that games like Flutter may best serve nature communicators as a re-engagement tool for hobbyists, or as a point of entry for new enthusiasts. While it was revealed that players had difficulty separating factual and fictional content, a large number of the surveyed participants (91%) were choosing to lookup information for themselves, or were part of the group who identified with being more engaged by the awareness they were gaining, potentially from the increased skill in identifying species. These types of 'meaning-making' activities, including both the personal and social elements recorded through these studies, are familiar in informal education literature associated with museums and hobbyist activities. For players expressing a newly developed interest in butterflies (30%), Flutter may represent a point of entry to butterflies, that both encourages a degree of foundational knowledge and skill at recognising species, but continues to keep them engaged in their personal spaces and close social networks. Both of these outcomes identify a potential opportunity for nature communicators seeking to extend their own outreach activities beyond the confines of the site, be it butterfly house, garden, or wildlife area. It also may provide a channel for communicators to advertise themselves to these audiences through collaborations with game developers presenting relatable factual content within their games.

There are broader opportunities in working with and learning from game development as well. Firstly, games offer insight into attracting and maintaining engaged audiences. Secondly, by taking advantage of behavioural metrics inherent to free-to-play games, less intrusive methods for measuring learning or engagement could be found as a supplement to individual pre- and post-testing. Finally, as these results suggest, young adult audiences may be influenced and engaged by factual content wrapped within entertainment-focused gaming media, which may be the case whether the content is intended to be learned or not.

5.4. The Future of Nature and Gaming

As was suggested in the opening chapter, the purpose of this thesis was to investigate what nature and video games may have to offer each other. Flutter has proven to be an ideal study platform for this, and has illustrated both deeper engagement opportunities for game developers, as well as extended outreach opportunities for nature communicators. Nothing can replace the importance of interactions in an outdoor nature setting. The intricate systems, personal discovery, and experiences that come from time outdoors are too complex for any single game to contain. However, games like Flutter may still play a role in raising awareness and keeping people engaged with the natural world in personal and meaningful ways. As Dickey (2005) points-out, games are designed to be engaging, and this may be their biggest strength and contribution. But engaging game mechanics alone are not enough to hold audiences, and innovative new experiences will be needed. The natural world may contain the inspiration for these experiences, either by connecting players with something meaningful beyond the confines of their screen, or by identifying new mechanics and markets previously unexplored. The attentive inclusion of nature related content may then simultaneously introduce new audiences to aspects of nature, while opening up new opportunities for collaborations with nature centres around the world.

5.5. Areas of Further Study

Throughout the course of this research, a number of interesting challenges have presented themselves as areas for further study. A number of individual question improvements were identified within the survey itself, and I would be very interested in separating the gameplay and factual content into discrete interest scales for further analysis. This could also be investigated more closely with the what players perceive to be gaining from the game factually, as well as by investigating which elements are more likely to be contributing to the overall experience. Some examples include: 'sound effects/ambience', 'mission quiz', 'accurate wing patterns', 'scientific name', 'species fact'. These scales could also offer more clarity on what players preferred to share and engage with.

Although a direct measure of what players were learning was not achieved by the variables used in Chapter 3, the potential of using game metrics to make non-intrusive observations remains a fascinating area of study for me. The unexpected results pertaining to player recognition of species validates the use of metrics data in this way to me. In light of this, the next most obvious step would be to create variables to target additional actions players take between receiving a mission question, and completing it. Recording what other menus were opened after a mission question was received by the player, or whether or not the Flutterpedia was opened, may provide clarity on how effective players were at learning to associate facts with butterflies. Another method may be to record the time a mission question was presented versus when it was finished. This could be used to see how long it took players to respond to each question, and potentially offer a stronger correlation to the number of times a question had been seen. Finally, the ability to identify individual users would greatly improve clarity of these results by allowing individual performance to be tracked through each mission interaction.

Another element I am particularly fascinated by is the ability for games to teach mechanics and behaviours relevant to the gameplay, and how that could be further utilised for learning and meaningful play experiences. In each of these cases, exploring content mastery through metrics and gameplay dynamics instead of pre and post-testing would be of interest. I believe the strength of games lies in what they encourage players to practice through the experience of playing. This can be likened to learning social skills and teamwork skills from physical sports games, or tactical skills from games like chess or Go. It would be of great interest to set up a study that first looks into the skills players may be developing at different points in a gameplay loop, and then devise a method for recording whether players could be shown progressing their real-world knowledge along with the game itself. In Flutter, one way of doing this might be to look at the content players are practicing at each milestone of the game, and create tests or metrics listeners to record how successfully players react to similar tasks.

Lastly, there is more that could be done with the results already collected, particularly through the coding and comparing of question types. Game developers may be interested in exploring which types of questions were more likely to be skipped, and what relationships exist between the associated rewards, perceived question difficulty, and player spending. Nature communicators may find value in further categorising and comparing the question groups and the factual content contained there. Any metrics relating to which questions players chose to skip more than others could then also identify types of content players were finding more challenging, or less interested in.

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APPENDIX A. OLD MISSION QUESTIONS AND GROUPS IN FLUTTER

A.1. Questions Used in Metrics Analysis

TABLE A.1: OLD MISSIONS QUESTIONS GROUPED BY FACT

Old mission questions relating to butterfly facts were considered difficult for players to lookup, and could only be found in the Flutterpedia. They are identified below based on the associated hint (in caps). Secondary and Tertiary content likely made little difference on the overall outcome.

missionID	Question Text: Fact	Secondary Content	Tertiary Content
9	I'd like to study this PHENOMENON of "PUPAL MATING" a bit more.		
16	I need to warn away some predators, where is a POISONOUS LOOKING butterfly?	colour/ pattern	
18	Do you know of any butterflies that have come from the fabled "BUTTERFLY KINGDOM?"		
25	The MALAYSIAN people are looking for their NATIONAL BUTTERFLY.	region	
31	I need a butterfly suited to exploring the COAST around CAPE TOWN.	region	
33	It's such a beautiful day. Do you have a butterfly that particularly LIKES SUNBATHING?		
51	Do you have a butterfly that would be FAMILIAR with the YELLOW PASSION FLOWER?		
66	I'm looking for a butterfly whose had a CLOSE RELATIONSHIP with ANTS while GROWING UP.		
99	Which species do you think would be suited to leading a great AMERICAN MIGRATION?	region	

TABLE A.2: OLD MISSION QUESTIONS GROUPED BY REGION

Old mission questions relating to region could only be found within the Flutterpedia and were considered difficult for players to lookup. They are identified below based on the associated hint (in caps).

missionID	Question Text: Region	Secondary Content	Tertiary Content
6	Could a butterfly help to decode some ancient AZTEC symbols?		
22	I need a butterfly from the HIMALAYAS to investigate a snow-capped mountain.		
69	Which butterfly could deliver an important message to the HIGHLANDS of NEW GUINEA?		

TABLE A.3: OLD MISSION QUESTIONS GROUPED BY SCIENTIFIC NAME

Old mission questions relating to a scientific name could only be found within the Flutterpedia and were considered difficult for players to lookup. They are identified below based on the associated hint (in caps). Secondary and Tertiary content likely did not have an impact as it did not reveal information easily identified on the Sanctuary Screen.

missionID	Question Text: Scientific Name	Secondary Content	Tertiary Content
12	Your CALLICORE CYNOSURA would love to go explore the canopy.		
20	I need the disruptive patterning of a DRYADULA PHAETUSA to play a prank my parrot friend.	fact	
30	I need a MYLOTHRIS AGATHINA to help a bird friend of mine build their nest.		
35	Your SEVENIA PECHUELI would love to find a nice marshy area in which to relax for a spell.	fact	
40	Your LEPTIDEA SINAPIS would love to go and play with some foxes in the countryside.	region	
42	Predators incoming! I need an INACHIS IO to warn them away.	fact	
46	Your CEPHEUPTYCHIA CEPUS would love to spend more time with the monkeys.		
50	That poisonous looking HELICONIUS CHARITHONIA could help deter some peckish birds!	colour/ pattern	
53	We have a sick leopard on our hands! Can your RHETUS PERIANDER assist?	name/ common	
55	Your MECHANITIS POLYMNIA would love to ride on the back of a speeding leopard!	colour/ pattern	
57	Look! A group of MORPHO PELEIDES are massing over there. Could we join the party?		
60	Think your CITHAERIAS PHANTOMA would be suited to a stealthy little mission?		
62	Your NAPEOCLES JUCUNDA would love to explore the slopes of the Andes.	region	
64	Your THECLINESTHES ONYCHA has a message to deliver to the Gardens by the Bay.	region	
68	Could your GRAPHIUM WEISKEI help us scout out some new fauna?		
70	Could your TAENARIS CATOPS investigate that mad howling noise?		
85	Could an APPIAS NERO keep some natives below company while they prepare a feast?		
87	Your CETHOSIA BIBLIS would love to visit the TAJ MAHAL.	region	
90	Your PRIONERIS CLEMANTHE would love to go play with some Bengal Tiger cubs.	Region	
98	Oh no, a great MIGRATION has got off track. Can a DANAUS PLEXIPPUS help them out?	fact	
76	Can a HELICONIUS butterfly sneak into the dragonflies' hideout for me?	colour/ pattern	
78	I would like to send away a PAPILIO for study of its interesting wing shape.	colour/ pattern	

A.2. Questions Omitted from Metrics Analysis

TABLE A.4: OLD MISSION QUESTIONS GROUPED BY COMMON NAME

Old mission questions grouped by common name could be found on a number of screens, and were omitted because players could identify the correct answer without registering any guesses.
(continued on Table A.5)

missionID	Question Text: Common Name	Secondary Content	Tertiary Content
4	Could your PALE SUPHUR help me with a little task?		
7	Your SARA LONGWING would love to go on a fungi safari.		
10	Could your BD help zip through the undergrowth for me?	colour/ pattern	
14	Your COMMON JEZEBEL would like to visit his tree monkey friends.		
17	Do you have a butterfly that could BLEND into the SPOTS of a LEOPARD?	colour/ pattern	
19	Could your BANDED ORANGE help us scout for some new sanctuaries?	colour/ pattern	
21	Is there a COMMON ROSE who can scout out some new roosting spots?		
23	Could your RAJAH BROOKES BIRDWING adorn the hair of a priestess for a ceremony?		
26	I think the wings of a SEA GREEN SWALLOWTAIL would blend nicely into the Amazon waters	colour/ pattern	region
28	Could your DOTTED BORDER help collect some specimens for study?		
32	Your WESTERN BLUE BEAUTY would love to explore the great African Lake, Victoria.	region	colour/ pattern
34	Woah what was that strange creature!? Could your SPOTTED LILAC TREE NYMPH track it for me?		
37	We need your WOOD WHITE to help spread some spores through the forest.		
41	A plump little bumble bee got himself stuck! Could your PEACOCK butterfly help out?	colour/ pattern	
45	Could your CEPHUS BLUE RINGLET go tell those noisy monkeys to keep it down?!	colour/ pattern	
48	Your ZEBRA LONGWING fancies a trip up to the Emergent layer of the forest.	colour/ pattern	
52	I need some specimens collected for study. Could your BLUE DOCTOR help?	colour/ pattern	
54	Could your TIGERWING help us make friends with a big cat?	colour/ pattern	
56	Your BLUE MORPHO would love to see a water lily bloom at night.	colour/ pattern	
58	Your shy little PARADISE PHANTOM would like to take some shelter in the undergrowth		
61	Could your GREAT BLUE HOOKWING delight the Peruvian people with a dance?	region	
63	Could your CYCAD BLUE help keep an eye out for predators?	colour/ pattern	
67	I bet the colorful wings of a PURPLE SPOTTED SWALLOWTAIL could cheer up that Lemur.	colour/ pattern	
71	Quick! We need the eye spots of your SILKY OWL to scare away some hungry parrots!	colour/ pattern	
74	I need a butterfly with a CAT-LIKE NAME to help butterfly-leopard relations.		
75	There's an inter-forest gliding competition! Let's enter one of our LONGWINGS.	colour/ pattern	
84	Your ORANGE ALBATROSS can smell something cooking, let's investigate!	colour/ pattern	
86	Could your RED LACEWING deliver a message to the Himalayas for me?	region	colour/ pattern
89	Could your RED SPOT SAWTOOTH help me locate a rare fungi?	colour/ pattern	
95	Your SILVERY BLUE wants to get into a race with a few other Amazonian butterflies.	region	colour/ pattern

TABLE A.5: OLD MISSION QUESTIONS GROUPED BY COMMON NAME (CONT.)

Old mission questions grouped by common name could be found on a number of screens, and were omitted because players could identify the correct answer without registering any guesses. (continued from Table A.4)

missionID	Question Text: Common Name	Secondary Content	Tertiary Content
96	There's a game of hide and seek going on, I bet your GLASSWING would be great at it!		
97	It's time for a great migration, do we have a MONARCH around?	fact	
100	Can your SPICEBUSH SWALLOWTAIL swoop down to the forest floor for me?	fact	

TABLE A.6: OLD MISSION QUESTIONS GROUPED BY WING COLOUR/PATTERN

Old mission questions grouped by butterfly wing colour/pattern could be found on a number of screens, and were omitted because players could identify the correct answer without registering any guesses.

missionID	Question Text: Color/Pattern	Secondary Content	Tertiary Content
5	Some leafcutter ants need help from a GREEN butterfly to collect their harvest.		
8	We need a BLUE butterfly to help track down a missing baby dolphin!		
11	Could an ORANGE butterfly help the hard working-ants with their foraging?		
13	Where is that butterfly that looks like it has LETTERS painted on it's WINGS?		
39	Your frog is feeling a little off color. Could a WHITE butterfly find a treatment for him?		
44	Can a SMALL BLUE butterfly help reunite a family of river dolphins lost in the floods below?	size	
49	Do you have a STRIPED butterfly that would feel right at home in FLORIDA?	region	
59	Could a cute little PINK butterfly help me cheer up some Amazonian children?	region	
73	Uh oh, I feel predators lurking, where's a butterfly with EYE-SPOTS?		
77	Let's send a SWALLOWTAIL to greet the new inhabitants of our neighbouring tree.	name/ common	

TABLE A.7: OLD MISSION QUESTIONS GROUPED BY RARITY

Old mission questions grouped by the game defined rarity were considered non-factual, and therefore fell outside the bounds of this study.

missionID	Question Text: Rarity	Secondary Content	Tertiary Content
24	An UNCOMMON butterfly is needed urgently to help sabotage a logging crew!		
27	I have a dangerous mission, only a RARE butterfly would be up to the task!		
72	Oh no! Loggers on their way to our tree! We need an EPIC butterfly to lead a resistance!		
81	Let's choose a friendly COMMON butterfly to make friends with the surrounding wildlife.		
82	Hey! A spider-monkey just stole my dinner! Send an UNCOMMON butterfly to get it back!		
91	I need an EPIC butterfly to go UNDERCOVER with a group of COMMON JEZEBELS.	fact	colour/ pattern
92	A special Orchid is on the brink of extinction. We need an EPIC butterfly to help with pollination.		

TABLE A.8: OLD MISSION QUESTIONS GROUPED BY SIZE

Old mission questions grouped by the game defined size were considered non-factual, and therefore fell outside the bounds of this study.

missionID	Question Text: Size	Secondary Content	Tertiary Content
1	I need a SMALL butterfly to sneak through the underbrush for me.		
2	Is there a MEDIUM butterfly who can help pollinate some flowers?		
3	I need a LARGE butterfly to help scare away some smugglers.		
36	A leopard cub has lost her mother! Can a SMALL butterfly help them reunite?		
79	Could a SMALL butterfly sneak over to our neighbouring forest to see whats going on?		
80	All the butterflies are gathering for a MEDIUM wing-pattern fashion show. Let's enter!		
88	Look out! Anteater! Send out a MEDIUM butterfly to warn our leaf-cutter friends!		
93	Some dragonflies are teasing that poor monkey! Send a LARGE butterfly to sort them out.		

TABLE A.9: OLD MISSION QUESTIONS GROUPED BY SET

Old mission questions grouped by game defined sets were considered non-factual, and therefore fell outside the bounds of this study.

missionID	Question Text: Set	Secondary Content	Tertiary Content
15	Perhaps a WAYANG set butterfly could help me with my current conundrum.		
29	What's that gruesome sound? Could we send a MAUA butterfly to investigate?	set	
38	I need a MARIPOSA butterfly to track some trouble-making dragonflies.		
43	The Amazonian people would love a MAYAN STAR butterfly to join in on a ritual.	Region	
47	Is there a MAYAN STAR butterfly who would be good at scouting round the understory?		
65	Would a PAPAKURA set butterfly be brave enough to try crossing the Tasman sea?	Region	
83	Could a TURMERIC set butterfly help collect some delicious spices?		
94	Can a CITLALI butterfly help the Amazon people find some more Brazil Nuts to harvest?	Region	

APPENDIX B: TESTING FLUTTER METRICS CONDITIONS

B.1. Understanding Metrics Conditions

To extract player interactions from the metrics data collected by the Mission System, new variables were implemented by the Runaway development team relating to two behavioural conditions. As discussed in Chapter 3, these conditions recorded either if a mission had been completed by a player, MissionComplete, or skipped by the player, MissionSkipped. Variables were assigned to each condition to collect more information about the interaction. Although individual users could not be isolated, the variables provided a means to identify player trends relating to how often a question was presented, how many incorrect attempts were made, and how frequently each condition was met.

Condition 1: MissionComplete(missionID_#PreviouslyPresented_#Wrong)

Using the variables missionID, #PreviouslyPresented, and #Wrong, this condition recorded the number of times each day that a question was completed (MissionComplete), how many times a player had seen the question before (#PreviouslyPresented), and how many incorrect butterflies or 'guesses' they used (#Wrong) for the attempt. It is important to note that although the #Wrong relates only to specific instances within the two week period, the #PreviouslyPresented reports how many times the mission had been encountered during the player's lifetime within the game. To illustrate this concept, consider Completed Examples 1 and 2 below:

COMPLETED EXAMPLE 1:

The first blue box in Table B.1 indicates that 8 people completed Mission 18 (missionID) for the first time (#PreviouslyPresented) and tried 7 incorrect butterflies (#Wrong) before completing it on October 10th, 2014.

COMPLETED EXAMPLE 2:

Described slightly differently, the second blue box in Table B.1 shows that on their second time (#PreviouslyPresented) seeing Mission 18 (missionID), 35 people (blue box) completed it on October 11th, 2014 without using any incorrect butterflies (#Wrong).

TABLE B.1: COMPLETED MISSION EXAMPLES 1 AND 2

Individual player metrics could not be recorded, instead, the total number of interactions for a condition and variables were tallied for each day.

missionID	#PreviouslyPresented	#Wrong	10/10/2014	10/11/2014	10/12/2014
18	1	7	8	-	-
18	1	9	-	-	-
18	2	0	-	35	37
18	2	1	11	-	-

Condition 2: MissionSkipped(missionID_WasExplicit_#Wrong)

The MissionSkipped condition contains almost the exact same variables as the MissionComplete condition above, except it also identifies a variable for how the mission was skipped. Since missions will automatically skip after a certain amount of time, a variable was added to identify situations when the player may not have interacted with the question at all (WasExplicit). A 0-value means the game automatically skipped the question, while a 1-value indicates a situation where the player paid Flutterbucks to skip the question to another. Using the same approach as above, consider these two examples:

SKIPPED EXAMPLE 1:

The first blue box in Table B.2 indicates that Mission 1 (missionID) was automatically skipped (WasExplicit) after 9 incorrect butterflies (#Wrong) were presented, one time (blue box) on October 2nd, 2014.

SKIPPED EXAMPLE 2:

Explained differently, the second blue box in Table B.2 indicates a question that was explicitly skipped (WasExplicit) by the player, without any incorrect butterflies being presented (#Wrong), 55 times on October 3rd, 2014.

TABLE B.2: SKIPPED EXAMPLES 1 AND 2

The Skipped condition also recorded the total number of interactions, but included a variable for identifying whether a mission was skipped by the user, or automatically by the game (WasExplicit).

	missionID	WasExplicit	#Wrong	10/2/2014	10/3/2014	10/4/2014
001_0_9	1	0	9	1	-	-
001_1_0	1	1	0	61	55	50
001_1_1	1	1	1	-	-	-

B.2. Testing Metrics Conditions

Metrics conditions and custom variables were implemented by the development team at Runaway, and tested in a single user version of Flutter maintained offline. The tests were conducted over several weeks, and served to verify the function of the new conditions and their variables. Testing occurred by recording each mission question separately and noting the number and type of interactions made. A number of imagined user situations were then anticipated, including the order in which butterflies were used, automatic MissionSkipped with and without player activity, repeated MissionComplete conditions with varying numbers of incorrect butterflies, and so on. In each case, the recorded notes were compared to the metrics provided by the Runaway development team, and no errors were found. Despite these tests, however, one error was uncovered within the final results, but was easily addressed as being related to game crashes during play. These are observed as 0-values recorded by the #PreviouslyPresented variable discussed later. Given that this variable recorded how many times the question had been presented to the user, starting with 1, a 0-value indicates an error instead of a valid tally.

APPENDIX C: FLUTTER SURVEY QUESTIONS AS PRESENTED IN TYPEFORM

C.1. Participant Consent and Demographics Questions

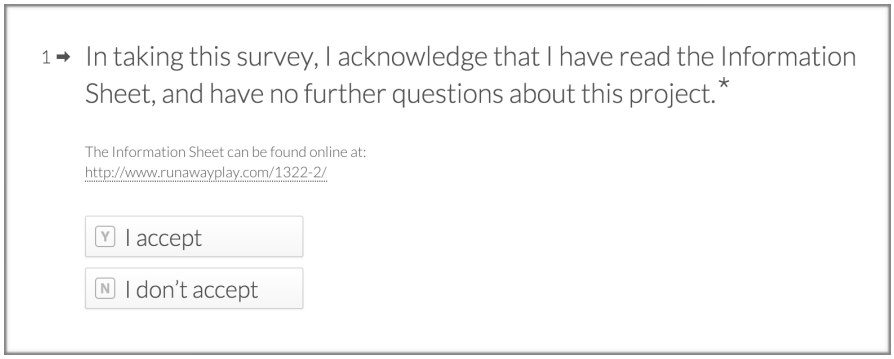


FIGURE C.1: PRESENTATION OF QUESTION 1

Question 1 was used to get consent from participants and connect them to the Information Sheet containing details about the project and their rights.

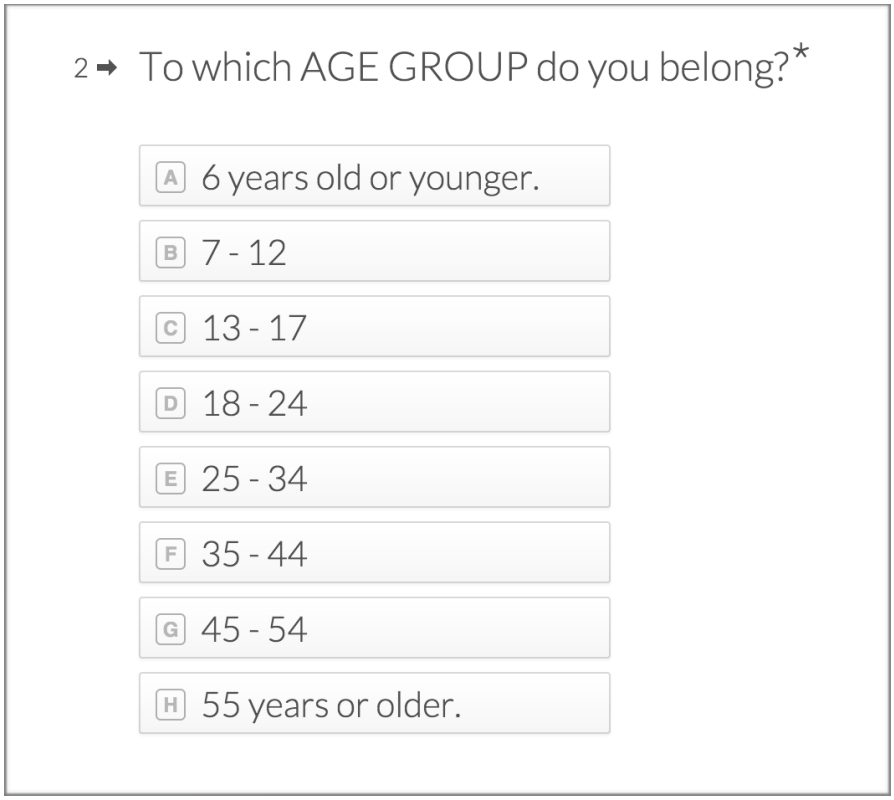


FIGURE C.2: PRESENTATION OF QUESTION 2

Question 2 was used to collect age related demographics that could be compared with broader Facebook metrics. Participants identifying as under 13 would be funnelled to the end 'Thank You' screen of the survey.

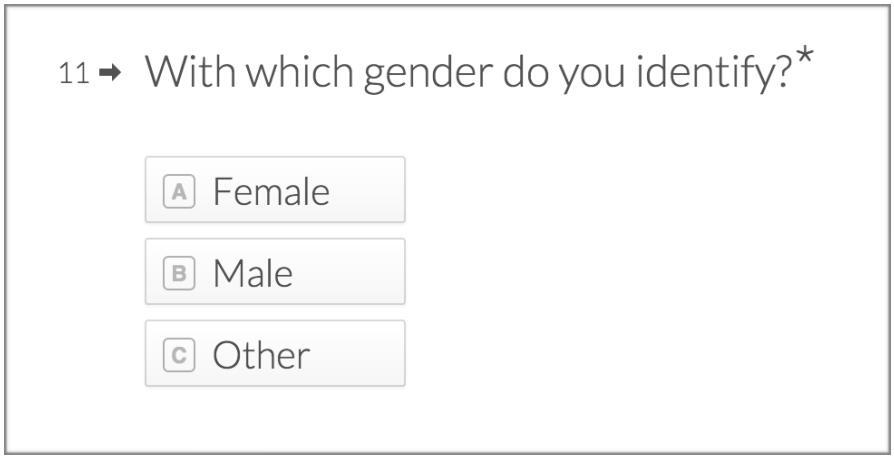


FIGURE C.3: PRESENTATION OF QUESTION 11

Question 11 collected gender preferences from participants and was used to make comparisons with broader Facebook gender metrics.

C.2. Participant Interest and Factual Content Questions

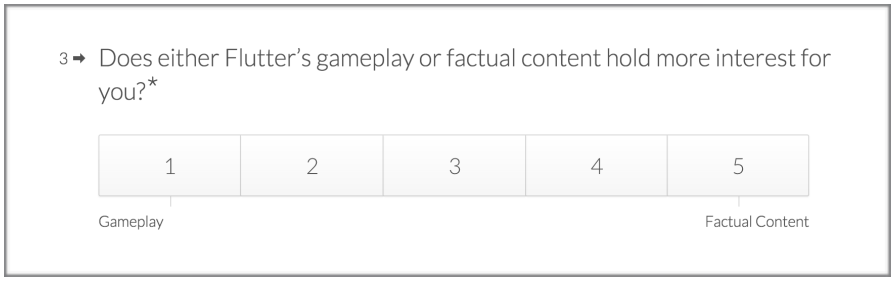


FIGURE C.4: PRESENTATION OF QUESTION 3

Question 3 recorded participant preference for either gameplay or factual content, and was used in Kruskal-Wallis tests to reveal spending and sharing trends.

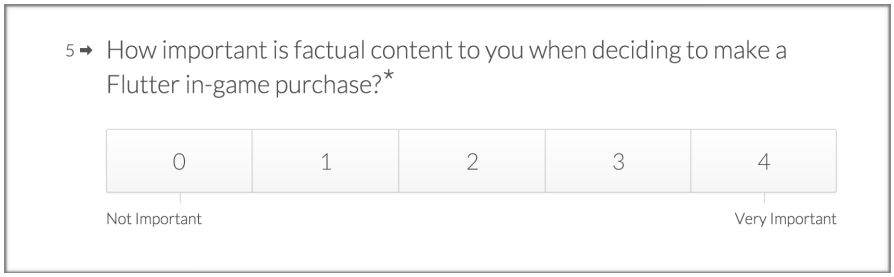


FIGURE C.5: PRESENTATION OF QUESTION 5

Question 5 recorded the perceived importance of factual content to survey participants, and was used in Kruskal-Wallis tests to reveal spending and sharing trends.

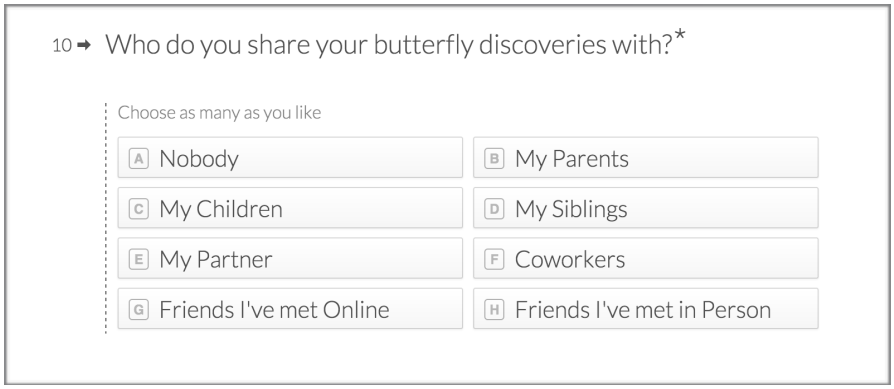


FIGURE C.6: PRESENTATION OF QUESTION 10

Question 10 recorded whether participants were sharing the discoveries they made in Flutter.

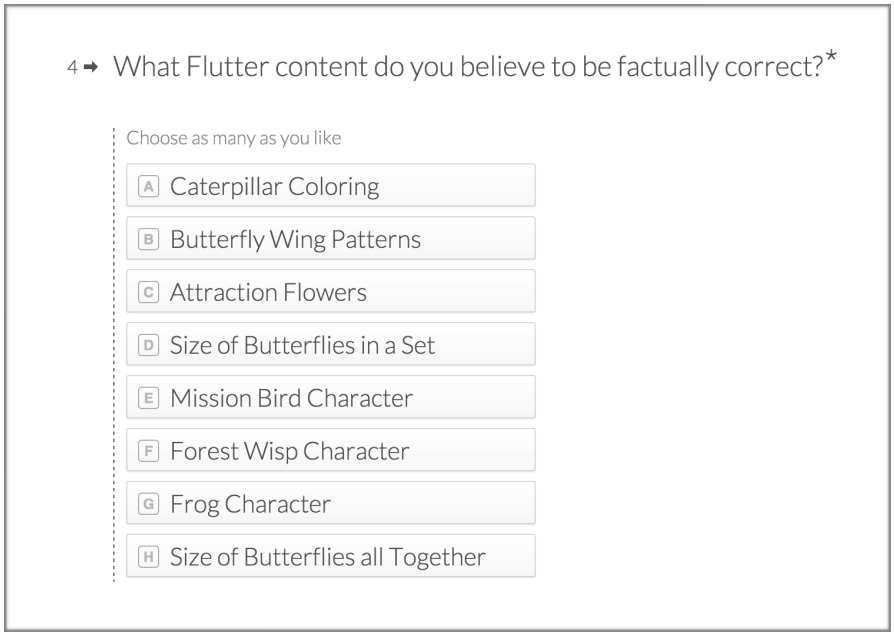


FIGURE C.7: PRESENTATION OF QUESTION 4

Selections B, D, E, and G represent factually researched elements of Flutter. Selections A, C, F, and H are considered non-factual design choices made by the Runaway team and not accurately represented.

C.3. Participant Interest and Access to Butterflies Questions

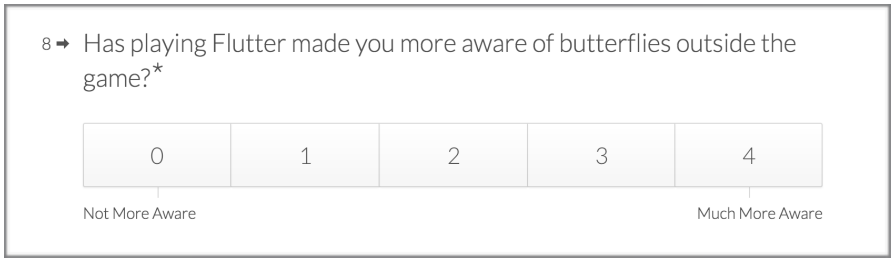


FIGURE C.8: PRESENTATION OF QUESTION 8

Question 8 recorded perceived awareness of butterflies in relation to playing Flutter, and was used in Kruskal-Wallis tests to reveal trends relating to generating interest in butterflies outside of Flutter.

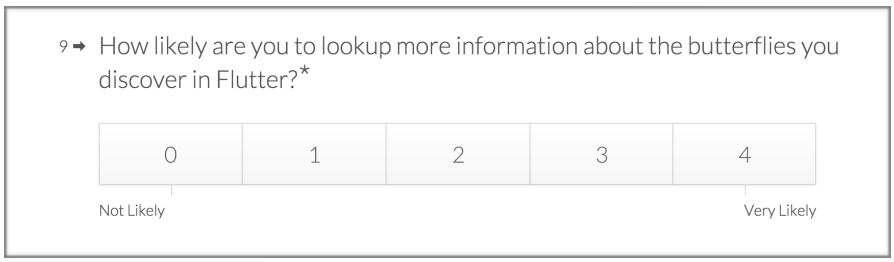


FIGURE C.9: PRESENTATION OF QUESTION 9

Question 9 recorded the perceived likelihood of seeking more information about butterflies discovered in Flutter, and was used in Kruskal-Wallis tests to reveal trends relating to generating interest in butterflies outside of Flutter.



FIGURE C.10: PRESENTATION OF QUESTION 6

Question 6 recorded whether participants had prior interest in butterflies, and was used in Kruskal-Wallis tests to reveal trends relating to whether Flutter could be connected to generating interest in butterflies outside the game.

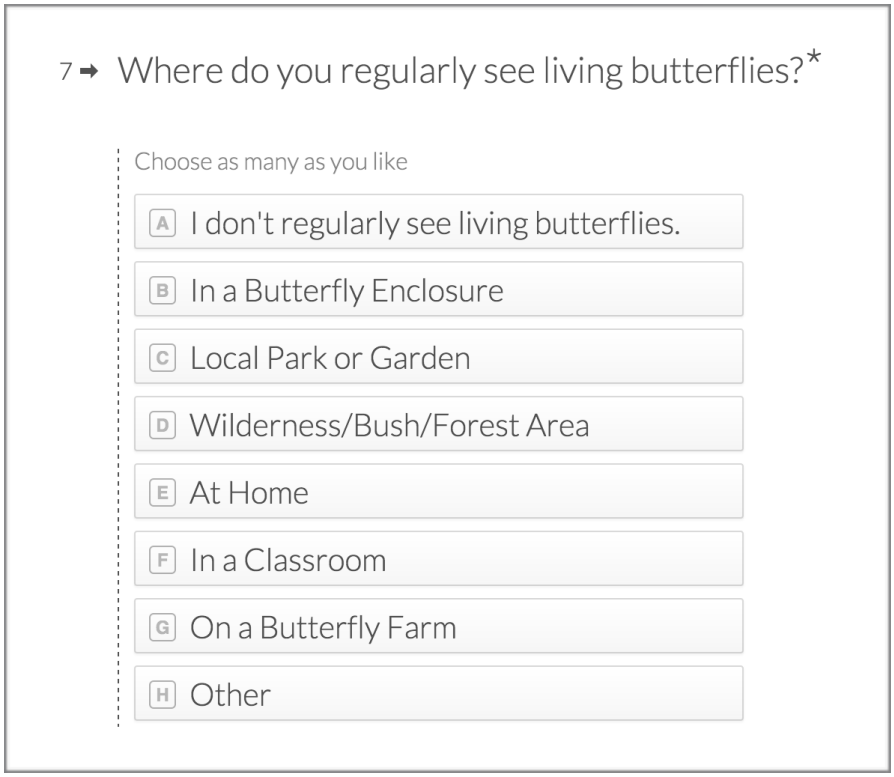


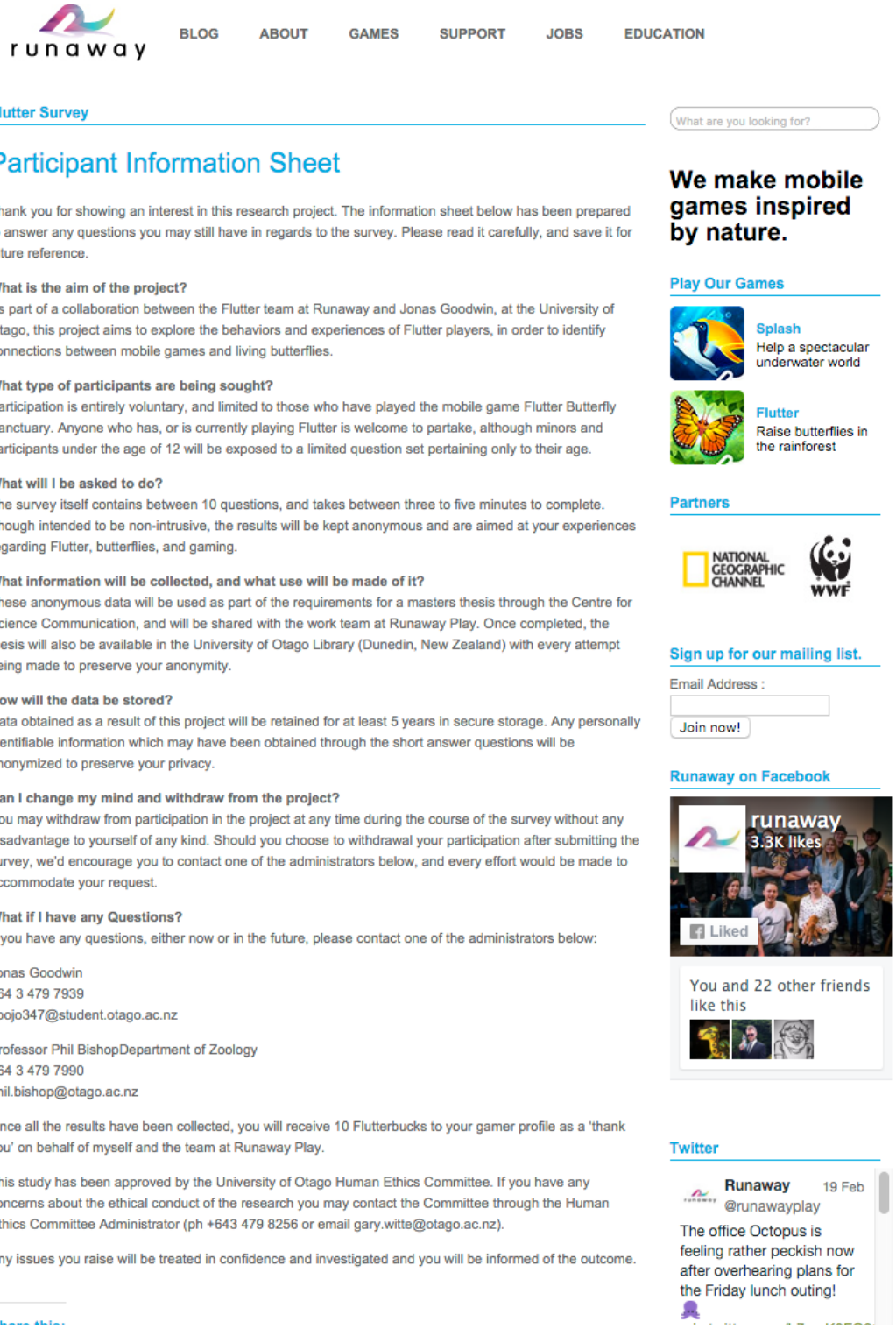
FIGURE C11: PRESENTATION OF QUESTION 7

Question 7 asked participants to identify where they see living butterflies, and was used to discuss whether or not participants had access to living butterflies.

APPENDIX D: ONLINE PARTICIPANT INFORMATION SHEET

FIGURE D.1: SURVEY PARTICIPANT INFORMATION SHEET

In accordance with the University of Otago Ethics Committee requirements, a Participant Information Sheet was made available online. This was referenced by a link in text before, during, and after the survey had been completed (http://www.runawayplay.com/1322-2/).



runaway

BLOG ABOUT GAMES SUPPORT JOBS EDUCATION

Flutter Survey

Participant Information Sheet

Thank you for showing an interest in this research project. The information sheet below has been prepared to answer any questions you may still have in regards to the survey. Please read it carefully, and save it for future reference.

What is the aim of the project?
As part of a collaboration between the Flutter team at Runaway and Jonas Goodwin, at the University of Otago, this project aims to explore the behaviors and experiences of Flutter players, in order to identify connections between mobile games and living butterflies.

What type of participants are being sought?
Participation is entirely voluntary, and limited to those who have played the mobile game Flutter Butterfly Sanctuary. Anyone who has, or is currently playing Flutter is welcome to partake, although minors and participants under the age of 12 will be exposed to a limited question set pertaining only to their age.

What will I be asked to do?
The survey itself contains between 10 questions, and takes between three to five minutes to complete. Though intended to be non-intrusive, the results will be kept anonymous and are aimed at your experiences regarding Flutter, butterflies, and gaming.

What information will be collected, and what use will be made of it?
These anonymous data will be used as part of the requirements for a masters thesis through the Centre for Science Communication, and will be shared with the work team at Runaway Play. Once completed, the thesis will also be available in the University of Otago Library (Dunedin, New Zealand) with every attempt being made to preserve your anonymity.

How will the data be stored?
Data obtained as a result of this project will be retained for at least 5 years in secure storage. Any personally identifiable information which may have been obtained through the short answer questions will be anonymized to preserve your privacy.

Can I change my mind and withdraw from the project?
You may withdraw from participation in the project at any time during the course of the survey without any disadvantage to yourself of any kind. Should you choose to withdrawal your participation after submitting the survey, we'd encourage you to contact one of the administrators below, and every effort would be made to accommodate your request.

What if I have any Questions?
If you have any questions, either now or in the future, please contact one of the administrators below:

Jonas Goodwin
+64 3 479 7939
goojo347@student.otago.ac.nz

Professor Phil BishopDepartment of Zoology
+64 3 479 7990
phil.bishop@otago.ac.nz

Once all the results have been collected, you will receive 10 Flutterbucks to your gamer profile as a 'thank you' on behalf of myself and the team at Runaway Play.

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph +643 479 8256 or email gary.witte@otago.ac.nz).

Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

What are you looking for?

We make mobile games inspired by nature.

Play Our Games

Splash
Help a spectacular underwater world

Flutter
Raise butterflies in the rainforest

Partners

NATIONAL GEOGRAPHIC CHANNEL

WWF

Sign up for our mailing list.

Email Address :

Join now!

Runaway on Facebook

runaway
3.3K likes
Liked

You and 22 other friends like this

Twitter

Runaway 19 Feb
@runawayplay
The office Octopus is feeling rather peckish now after overhearing plans for the Friday lunch outing!

APPENDIX E: KRUSKAL-WALLIS TEST RESULTS FOR SURVEYED INTEREST IN FACTUAL CONTENT

TABLE E.1: KRUSKAL-WALLIS RESULTS FOR SPENDING TO QUESTION 3

A Kruskal-Wallis test revealed no significant relationship (p=0.882) between spending level and whether participants chose gameplay or factual content in Question 3.

	Spending Groups	N	Mean Rank
Question 3. Does either Flutter's gameplay or factual content hold more interest for you?	*Low spending participants*	*6839*	*11634*
	Non-spending participants	*16270*	*11613*
	High spending participants	*126*	*11369*
	Total	***23235***	

	Question 3. Does either Flutter's gameplay or factual content hold more interest for you?
Chi-Square	*.252*
Degrees of freedom	*2*
Asymp. Sig.	*.882*

TABLE E.2: KRUSKAL-WALLIS RESULTS FOR SPENDING TO QUESTION 4

A Kruskal-Wallis Test revealed a significant relationship (p=0.003) between spending and how important factual content was consider to making purchases. High spending participants ranked the importance of factual content on spending decisions higher than non-spending and low spending groups.

	Spending Groups	N	Mean Rank
Question 5. How important is factual content to you when deciding to make a Flutter in-game purchase? (ranked highest to lowest importance)	High spending participants	126	12187
	Non-spending participants	16270	11705
	Low spending participants	6839	11400
	Total	**23235**	

	Question 5. How important is factual content to you when deciding to make a Flutter in-game purchase?
Chi-Square	11.501
Degrees of freedom	2
Asymp. Sig.	.003

TABLE E.3: KRUSKAL-WALLIS RESULTS FOR SPENDING GROUPS TO SHARING

A Kruskal-Wallis Test revealed a significant relationship (p<0.001) between spending groups and participants choosing the "Nobody" sharing option. Non-spending participants were shown to be more likely than other groups to identify with not sharing their discoveries with anyone, while the High spending participants tended to be the least likely to not share their discoveries.

	Spending Groups	N	Mean Rank
Question 10. Who do you share your Flutter butterfly discoveries with? (Nobody)	Non-spending participants	16270	11836
	Low spending participants	6839	11114
	High spending participants	126	10837
	Total	***23235***	

	Question 10. Who do you share your Flutter butterfly discoveries with? (Nobody)
Chi-Square	98.405
Degrees of freedom	2
Asymp. Sig.	.000

TABLE E.4: KRUSKAL-WALLIS RESULTS FOR PRIOR INTEREST IN BUTTERFLIES TO SPENDING GROUPS

A Kruskal-Wallis Test revealed a significant relationship (p<0.001) between key prior interest in butterfly groups and in-game spending. Players expressing a life-long interest in butterflies were tended to spend more highly than groups associating their interest in butterflies with Flutter and those identifying as not interested in butterflies.

	Question 6. Which best describes your interest in butterflies?	N	Mean Rank
Spending Groups (High spending to non-Spending)	***I've been interested in butterflies all my life***	11572	11865
	I became interested in butterflies over 5 years ago	994	11858
	I became interested within the last 5 years	643	11597
	I became interested after I started playing Flutter	7048	11437
	I became interested within the last 2 years	820	11403
	I'm NOT very interested in butterflies	2158	10864
	Total	***23235***	

	Spending Groups
Chi-Square	79.489
Degrees of freedom	5
Asymp. Sig.	.000

TABLE E.5: KRUSKAL-WALLIS RESULTS FOR CONTENT PREFERENCE TO SHARING

A Kruskal-Wallis Test revealed a significant relationship ($p<0.001$) between the gameplay and factual content preferences of Question 3 and whether participants identified as not sharing with anybody from Question 10. Groups expressing a preference for gameplay tended to identify sharing with "Nobody", while groups expressing a preference for factual content were more likely to share.

	Question 3. Does either Flutter's gameplay or factual content hold more interest for you?	N	Mean Rank
Question 10. Who do you share your Flutter butterfly discoveries with? (Nobody)	1 - Gameplay	2752	12824.74
	2	3049	12471.31
	3 - 'Equal Interest'	11430	11539.04
	4	3618	11071.42
	5 - Factual Content	2386	10342.78
	Total	***23235***	

	Question 10. Who do you share your Flutter butterfly discoveries with? (Nobody)
Chi-Square	427.610
Degrees of freedom	4
Asymp. Sig.	.000

APPENDIX F: KRUSKAL-WALLIS TEST RESULTS FOR SURVEY FACTUAL CONTENT IDENTIFICATION

TABLE F.1: WHAT IS THE RELATIONSHIP BETWEEN PARTICIPANT RESPONSES TO THE BUTTERFLY WING PATTERNS COMPARED TO OTHER FACTUAL AND NON-FACTUAL ELEMENTS?

A Kruskal-Wallis test revealed significant relationships (p<0.001) between participants who chose Butterfly Wing Patterns to be factual, and all other options except for Attraction Flowers, the Frog Character, and the Bird Character. This reveals that participants who thought the wing patterns were factual, tended to also think that the other elements were factual, except for the Wisp Mother and possibly the Attraction Flowers (p=0.010).

	Question 4. Butterfly Wing Patterns	N	Mean Rank
Question 4. Size of Butterflies all Together	Believed to be factual	18916	11752
	Believed to be not factual	4319	11031
	Total	**23235**	
Question 4. Caterpillar Coloring	Believed to be factual	18916	12015
	Believed to be not factual	4319	9879
	Total	**23235**	
Question 4. Attraction Flowers	*Believed to be not factual*	*4319*	*11795*
	Believed to be factual	*18916*	*11577*
	Total	***23235***	
Question 4. Forest Wisp Character	Believed to be not factual	4319	12021
	Believed to be factual	18916	11526
	Total	**23235**	
Question 4. Size of Butterflies in a Set	Believed to be factual	18916	11911
	Believed to be not factual	4319	10336
	Total	**23235**	
Question 4. Frog Character	*Believed to be factual*	*18916*	*11639*
	Believed to be not factual	*4319*	*11528*
	Total	***23235***	
Question 4. Mission Bird Character	*Believed to be factual*	*18916*	*11643*
	Believed to be not factual	*4319*	*11508*
	Total	***23235***	

	4. Size Together	4. Caterpillar Coloring	*4. Attraction Flowers*	4. Wisp Character	4. Size in a Set	*4. Frog Character*	*4. Bird Character*
Chi-Square	55.724	539.792	*6.592*	70.548	268.029	*2.165*	*3.619*
df	1	1	*1*	1	1	*1*	*1*
Asymp. Sig.	.000	.000	*.010*	.000	.000	*.141*	*.057*

TABLE F.2: WHAT IS THE RELATIONSHIP BETWEEN PARTICIPANT RESPONSES TO THE WISP CHARACTER COMPARED TO OTHER FACTUAL AND NON-FACTUAL ELEMENTS

A Kruskal-Wallis test revealed significant relationships (p<0.001) between participants who chose the Forest Wisp Character to be factual, and all other options. This revealed that participants who thought the Wisp Mother Character was factual, tended to also think the other elements were factual, except for Butterfly Wing Patterns.

	Question 4. Forest Wisp Character	N	Mean Rank
Question 4. Size of Butterflies all Together	Believed to be factual	2336	13795
	Believed to be not factual	20899	11375
	Total	**23235**	
Question 4. Caterpillar Coloring	Believed to be factual	2336	14910
	Believed to be not factual	20899	11250
	Total	**23235**	
Question 4. Attraction Flowers	Believed to be factual	2336	16302
	Believed to be not factual	20899	11095
	Total	**23235**	
Question 4. Size of Butterflies in a Set	Believed to be factual	2336	13935
	Believed to be not factual	20899	11359
	Total	**23235**	
Question 4. Frog Character	Believed to be factual	2336	16252
	Believed to be not factual	20899	11100
	Total	**23235**	
Question 4. Mission Bird Character	Believed to be factual	2336	16125
	Believed to be not factual	20899	11114
	Total	**23235**	
Question 4. Butterfly Wing Patterns	Believed to be not factual	20899	11701
	Believed to be factual	2336	10873
	Total	**23235**	

	4. Size Together	4. Caterpillar Coloring	4. Attraction Flowers	4. Size in a Set	4. Frog Character	4. Bird Character	4. Wing Patterns
Chi-Square	375.596	946.671	2248.035	428.714	2816.344	2986.651	70.548
df	1	1	1	1	1	1	1
Asymp. Sig.	.000	.000	.000	.000	.000	.000	.000

TABLE F.3: WHAT IS THE RELATIONSHIP BETWEEN PARTICIPANT RESPONSES TO THE FROG CHARACTER COMPARED TO OTHER FACTUAL AND NON-FACTUAL ELEMENTS?

A Kruskal-Wallis test revealed significant relationships (p<0.001) between participants who chose the Frog Character to be factual, and all other options. This revealed that participants who believed the Frog Character to be factual, tended to also identify the other elements as factual.

	Question 4. Frog Character	N	Mean Rank
Question 4. Size of Butterflies all Together	Believed to be factual	4150	13768
	Believed to be not factual	19085	11151
	Total	**23235**	
Question 4. Caterpillar Coloring	Believed to be factual	4150	14025
	Believed to be not factual	19085	11095
	Total	**23235**	
Question 4. Attraction Flowers	Believed to be factual	4150	14763
	Believed to be not factual	19085	10934
	Total	**23235**	
Question 4. Forest Wisp Character	Believed to be factual	4150	14226
	Believed to be not factual	19085	11051
	Total	**23235**	
Question 4. Size of Butterflies in a Set	Believed to be factual	4150	13706
	Believed to be not factual	19085	11164
	Total	**23235**	
Question 4. Mission Bird Character	Believed to be factual	4150	16140
	Believed to be not factual	19085	10635
	Total	**23235**	
Question 4. Butterfly Wing Patterns	*Believed to be factual*	*4150*	*11712*
	Believed to be not factual	*19085*	*11598*
	Total	***23235***	

	4. Size of Butterflies all Together	4. Caterpillar Coloring	4. Attraction Flowers	4. Wisp Character	4. Size in a Set	4. Bird Character	*4. Wing Patterns*
Chi-Square	712.767	984.551	1971.395	2816.344	677.478	5848.875	*2.165*
df	1	1	1	1	1	1	*1*
Asymp. Sig.	.000	.000	.000	.000	.000	.000	*.141*

APPENDIX G: KRUSKAL-WALLIS REST RESULTS FOR SURVEYED INTEREST LIVING BUTTERFLIES

TABLE G.1: WHAT IS THE RELATIONSHIP BETWEEN THE LIKELIHOOD OF LOOKING-UP MORE INFORMATION AND AWARENESS OF BUTTERFLIES OUTSIDE OF THE GAME?

A Kruskal-Wallis test revealed a statistically significant difference (p<0.001) that revealed participants who reported being more likely to lookup information, also tended to be more likely to report increased awareness of butterflies outside of the game as well.

	Question 9. How likely are you to lookup more information about the butterflies you discover in Flutter?	N	Mean Rank
Question 8. Has playing Flutter made you more aware of butterflies outside the game? (ranked least aware to most aware)	Not likely	2077	4822
	1 - "unlikely"	2406	7291
	2 - "equally likely"	5701	9722
	3 - "likely"	6516	12398
	Very likely	6535	16247
	Total	**23235**	

	Question 8. Has playing Flutter made you more aware of butterflies outside the game?
Chi-Square	7346.366
df	4
Asymp. Sig.	.000

TABLE G.2: WHAT IS THE RELATIONSHIP BETWEEN PARTICIPANT PRIOR INTEREST IN BUTTERFLIES AND THEIR REPORTED AWARENESS OF BUTTERFLIES OUTSIDE THE GAME?

A Kruskal-Wallis Test revealed a statistically significant difference (p<0.001) that revealed participants who associate their interest in butterflies with Flutter, tended also to report an increased awareness of butterflies outside of the game. Participants expressing no interest in butterflies, reported less increases to awareness than either of the other groups.

	Question 6. Which best describes your interest in butterflies?	N	Mean Rank
Question 8. Has playing Flutter made you more aware of butterflies outside the game? (ranked most aware to least aware)	***I became interested after I started playing Flutter***	***7048***	***12575***
	I became interested within the last 5 years	643	12242
	I've been interested in butterflies all my life	***11572***	***11913***
	I became interested within the last 2 years	820	11900
	I became interested in butterflies over 5 years ago	994	11621
	I'm NOT very interested in butterflies	***2158***	***6617***
	Total	**23235**	

	Question 8. Has playing Flutter made you more aware of butterflies outside the game?
Chi-Square	1485.159
df	5
Asymp. Sig.	.000

TABLE G.3: WHAT IS THE RELATIONSHIP BETWEEN PARTICIPANT PRIOR INTEREST IN BUTTERFLIES AND THEIR REPORTED LIKELIHOOD TO LOOK-UP MORE INFORMATION OUTSIDE THE GAME?

A Kruskal-Wallis Test revealed a statistically significant difference (p<0.001) in reported likelihood to lookup more information about butterflies across five different butterfly interest levels. Both participants reporting a lack of interest in butterflies, and an interest associated with playing Flutter, were less likely than other interest groups to lookup information about the butterflies they had discovered.

	Question 6. Which best describes your interest in butterflies?	N	Mean Rank
Question 9. How likely are you to lookup more information about the butterflies you discover in Flutter? (ranked most likely to least likely)	I became interested in butterflies within the last 5 years	643	12805
	I've been interested in butterflies all my life	***11572***	***12760***
	I became interested in butterflies over 5 years ago	994	11842
	I became interested within the last 2 years	820	11817
	I became interested after I started playing Flutter	***7048***	***11491***
	I'm NOT very interested in butterflies	***2158***	***5377***
	Total	**23235**	

	9. How likely are you to lookup more information about the butterflies you discover in Flutter?
Chi-Square	2372.769
df	5
Asymp. Sig.	.000

APPENDIX H: NATURE CENTRED GAME DESIGN CONCEPT

H.1. Growing-Up Bug

In tandem with the research of this thesis, a casual game about freshwater food-webs was re-conceptualised for development, but was not produced given technical limitations and the broader research opportunities provided by Flutter. Given the working title Growing Up Bug 2.0, hereafter called GrUB, this was a casual game intended to emphasise discovery in nature. Like Flutter, it was to be partially based on the collection of insect sets, but utilised a different game genre to better reinforce interactions between characters. A genre shift was also considered important as GrUB intended to rely on a less popular insect cast, resulting it its placement as an action-simulation. The discussion of GrUB and associated elements is what follows.

H.2. Game Concepts

H.2.1. SUMMARY

GrUB is a 2D side-scrolling action-simulation game that puts players in the role of a dragonfly as it emerges into an unfamiliar where forced to eat and explore its way to the role top predator. Hatching into the mysteriously eerie world of pond insects, the player is challenged to make discoveries, while managing risks associated with the unknown through observation and head-to-head experimentation. As the player grows, so too does the world, unlocking darker and more challenging environments as well as less well known creatures. Continuous exploration leads to the phoenix-like rebirth of the character from the underwater to the aerial. As the dragonfly emerges in its final form, to soar above the surface of the pond, the player must continue collecting as many mosquitoes as possible, before being forced to lay eggs and restart the process all over again.

H.2.2. GRUB CORE CONCEPTS: DISCOVERY, RISK, AND OBSERVATION

Focusing on gameplay elements central to the action-adventure genre; discovery, risk, and observation have each been uniquely applied to reinforce the factual content, and facilitate an enjoyable play experience within the game. The concept of discovery is emphasised factually through the unlocking of new cast members, but also functionally through the openly explorable pond environment.

Central to gameplay, the discovery process should always be initiated by the player, with results recorded by the game for convenient reference. The two main ways of making discoveries include players reacting to pre-scripted interactions of non-playable-character (NPC) events, or by directly provoking a reaction from an unknown cast member. In either case, the outcome is recorded by the game "memory" system. For example a mosquito larva character may be getting eaten by another dragonfly near the edge of the screen. Should the player notice this interaction, they can initiate an observational discovery, doing so records the interaction in a separate menu that can be accessed any time. For the more more active approach, the player may choose to initiate an interaction with a yet to be unlocked creature, like the praying mantis-like water stick insect. In this cases, the player will have managed their risk points, and will discover that when approached, the water stick insect attacks. This provokes the player's character to automatically escape, and will also record the interaction within the "memory" component of the game.

Risk-taking is complementary to the discovery process, and should be carefully balanced to provide players with critical feedback, as-well-as clear methods for managing their interactions. Taking the form of a 'fight-or-flight' survival point system, these provide the drama and excitement of tackling the unknown. Always present on the play screen, these points allow for risk analysis, as well as opportunities to discover new character interactions first-hand. Although uniquely applied in GrUB, each has an analogous game component, with 'flight' points acting like extra lives, and 'fight' points functioning to track the player's level or progress.

Fight points are not directly applied by the player, but are awarded as the player progresses through the game. These function to unlock new opportunities, and provide a means by which to track progress through the game. Progress is important to the player in that both map areas and new characters are part of what is unlocked, as well as opportunities for previously identified foes to become food. Flight points on-the-other-hand, are increased by player observation, and are awarded by either noting an observable NPC interaction, or by successfully provoking an unknown cast member. A successful interaction is one in which the player eats the unknown character, and was not attacked instead. For example,

when a player taps observable character interactions, such as a sibling being eaten by a predator, they will be rewarded with a point that allows the player to make a harrowing escape later. To help balance these low risk outcomes, observable opportunities will be provided more frequently during the early stages of the game, but less frequently as the levels progress.

As has been discussed through the other two elements, observation is a third core concept to GrUB. Players should be constantly watching for new creatures and creature interactions, but not be required to memorise them outright. This is the role of the memory menu, which keeps track of all creatures and interactions the player may need to reference as they progress in the game. Functioning similarly to the Flutterpedia in Flutter, this mechanic symbolises the character's memory and experience by visualising growth states, characters, and most importantly, who eats whom. The memory menu is critical to the concept of observation, in that it reinforces to the player the importance of noting the activities in their environment, while still functioning to take some of the pressure off remembering everything themselves.

H.3. Look and Feel

GrUB strikes a balance between the murky and 'scary' unknown darkness concepts, and ideas relating to the 'magical light of discovery'. Although the opening levels depict a more relaxed and happy atmosphere, the farther a player progresses results in darker more brooding backgrounds. A good reference for this can be found in the games of LIMBO (Playdead, 2014) and Spider: Secret of Bryce Manor (Tiger Style, 2014). The former represents the mysterious darkness captured by the game, while the later a more realistic depiction of its cast. Both elements are emphasised by tethering the discovery process to the illumination of the map. Cast whose interactions have already been identified might provide additional light and clarity to play screen, where-as unknowns remain darker less well defined shadows. As players enter less and less familiar environments, the style of the game would become more ominous and threatening. Countering this, as the player unlocks more interactions, the play space becomes increasingly well defined and 'friendly'.

Since the narrative is focused the main dragonfly character, the attributes and menus should also reflect this visually. Therefore, 'fight' and 'flight' points can be presented by images representing the predatory head and fleeing tail of the dragonlfy, while the memory menu can be constructed around the face and compound eyes. The face-like design further reinforces the concept of observation, with each cell of the compound eyes being able to unlock to an interaction, as if these are what the character has 'seen' in its lifetime.

H.4. Controls

Two different control styles would need play testing in order to identify the best application for GrUB. The first revolves around a thumb-tracking wheel and buttons, while the second utilises touch-screen gestures. Examples of the thumb wheel can be observed in the games Dragonfly Learning (Indigo Kids, 2015) and Galaxy on Fire 2 , where the player drives the turning and movement through the wheel, and additional attacks or speed burst(Fishlabs, 2009)s through buttons. Gestures may also work more efficiently within GrUB, providing players the ability to drive the dragonfly using methods similar to Flutter and Spider.

H.5. Narrative and Story

In order to emphasise the discovery aspect desired in the game, narrative focus is placed on the main character and their own learning process. The game revolves around the hatching of the main character, and generally explores the 'hero's journey' and 'rags to riches' story types. Both of these styles encourage experimentation on the part of the protagonist, and rely heavily on the hero overcoming the unknown successfully. The story should also unfold naturally through aspects of gameplay, and not just be told through cut-scene. This is particularly important in the opening levels, where mistakes would be met with escapes and opportunities to identify important gameplay elements in controlled interactions. Imagine then a lone dragonfly nymph hatching late after all its siblings have entered the world. Alone in and unfamiliar place, the player's experience with the game becomes mirrored by the protagonist's, and discovery begins through the mastery of controls, and the inadvertent interactions that the learning process creates.

Although hatching alone, the dragonfly siblings become one of the means to teach and progress the story. Through observation, the player should recognise the similar looking sibling creatures as they catch food, are chased, or even eaten within the environment around them. This provides the fist means through which to emphasise observation, as interactions can be explicitly illustrated through these characters in order to allow the player to unlock their ability to record such things. If intuition fails, direct interactions can also be accommodated with the introduction of flight points providing escape abilities. In this way, the story of a growing dragonfly unfolds as the player becomes more proficient with the controls and manages their interactions. Key benchmarks can be implemented to track progress, and narrative discoveries can be reinforced by strategically removing options in order to help guide the player to necessary observations.

H.6. Story

Emerging into an alien underwater world, you must use your skill, stealth, and speed to grow or die as you discover what it takes to be the best mosquito-muncher in the pond.

H.6.1. OPENING

A warm spring day illuminates the rippling water between the cattails and reeds at the edge of pond. Just beneath the surface, a change is taking place. A number of seed-like eggs, all nested in a clump, begin to wiggle. In an exuberant flurry, small pudgy insects wiggle free and strike off in different directions. All except one. As the flurry dies, you realise that one egg has yet to hatch. To a lonely score, your take charge of the final egg as it wiggles and breaks revealing the final pudgy baby… all alone in a big pond.

H.6.2. ACT 1: NEW NYMPHS

Newly emerged, you find yourself in a magical new world of sparkling sunbeams and the dancing fairy-like daphnia. Your first encounters are with your siblings as they dart and play, inadvertently teaching you how to catch and observe your first mosquito larva. But this new world is both strange and dangerous, with predators taking many different forms. As you find yourself in darker and murkier backdrops, creatures appear stranger and more threatening. As your siblings fall prey to the threats around, your best defences lie with your abilities to observe, react with lightning jets of speed, and sit almost invisibly. As you grow, however,

relationships unfold as you eventually discover that even the scariest things as a child, become charlatans as you age.

The level ends with a dramatic turn as you are left with only your enemies, and are forced to attack your attacker…and win!

H.6.3. ACT 2: THE DEVELOPING DRAGON

Having shed your fears, and the first few skins, you emerged into a shadowy new world that is stronger, smarter, and stranger than while you were a hatchling. New creatures are emerge within this shadowy forest, and many of your brothers and sister's have not made it; those that have, are now hardened against you. It is a dangerous new world, and its up to you to decide how best to use your powers. Do you stick with stealth, or risk it all gambling yourself the strongest. Either way your world is changing, time is limited as your food leaves the pond to fly away.

You explore several different areas through continued growth, but the act finally ends as you become trapped in a drying pool and are forced to climb arduously onto land, only to be baked and hardened in the summer heat.

H.6.4. ACT 3: A PHOENIX RISES

Your former life is little more than a shell as you burst forth and take to the skies. A dragonfly on the wing, you swoop and dive catching as many newly hatched insects as you can, devouring any mosquito that comes too close. Life has just about come full circle in the air, and some of the things you ate as a child have become bigger and badder. There are few escapes here, but your speed and agility keep you flying just long enough to discover the foes from food.

The game ends when your escapes are depleted and you are forced into laying eggs for the next generation of hatchling dragonflies.

H.7. Cast Characters

Drawing from the diversity of underwater creatures, this list only represents some of the animals that could be used in different levels of the game. Descriptions depict the visible life-cycle that can be discovered by the player, as well as their role in relation to each of the three acts.

Dragonfly - The dragonfly functions as the main character, and is often used as a teaching tool within Act 1. By the middle of Act 2 and early Act 3, the dragonfly

character has mostly been eliminated, after becoming a threat to the player by the middle of Act 2.

Mosquito - Mosquitoes are the basic food unit, and are readily available in any Act, with their primary function being Act 1. They progress through all three growth stages; larva, pupa, and adult, looking and behaving differently in each one.

Mayflies - Mayflies also appear in each Act, and are found in each growth stage. Like mosquitoes, these are always harmless and represent a slightly more advanced basic food.

Damselfly - Damselflies are depicted throughout their life cycle, first appearing as a dangerous predator in Act 1, then becoming food during the later levels.

Caddisfly - Caddisflies are another predator for Act 1 and early Act 2, which transition to food during the later. Caddisflies are represented through each of its growth stages, and are an edible flying insect in Act 3.

Predacious Diving Beetle - These represent a threat regardless of the player's level, but behave differently depending on whether the adult or larva presented. The adults are very active and fast, swimming after the player should they get too close. The larva are snappy but fairly stationary, hiding in muck and quick to strike. Larva are much better as Act 1 predators, and in tight quarters.

Water Scorpion - Water Scorpions are a clear threat as adults, but are a transition threat as larvae. The nymph start as predators in the early levels of Act 2, but transition during the mid-level stages, only to reappear as adults closer to the end of Act 2. They make no appearance in Act 3.

Water Stick Insect - Primarily an Act 1 or Act 2 threat, as it only appears in its adult form and is an obvious predator.

Dobsonfly - This fly is presented in all stages of its life, but is only a threat during Act 1 and early Act 2.

Frog - Frogs and tadpoles appear in three life-stages, but are only a threat as adults. This is likely one of the predators that force the end of the game, when the

dragonfly reaches adulthood and is eventually forced to lay eggs. Primarily used as food during the middle and end of Act 2.

Salamander - Salamanders appear in two stages, with both the adult and larva being threats to the main character. Looking similar to the Frog tadpoles makes them slightly more dangerous to the player. These are a late Act 2 predator.

Fish - Small fish are food, but older fish are threats during the later parts of Act 2. Many different fish species could be used to give a mid-game level more diversity. In Act 3 they leap out of the water to try and catch the dragonfly.

Back-swimmers - Appear as threats at each life-stage except adult, where the dragonfly can eat them by the middle or end of Act 2. Wingless nymphs attack the early game player, while winged adults can chase and attack the mid-level player. By Act 3 they are clumsy and edible in the air.

Water Boatsmen - Applicable during all Acts of the game, these look very similar to the Back-swimmers, but are always harmless, making them a complementary addition to the middle of Act 2.

H.8. The Importance of What Is Practiced

In Flutter, players practice collecting butterflies with flowers, and growing them through a life cycle. The Mission System encourages players to recognise butterflies visually, and practice relating those visuals to names and facts. This reinforced practiced behaviour seems critical to tying some degree of discovery and learning to the game and is encouraged through the way new sets and butterflies are unlocked. This is by no means the only way of building this element of discovery into a game like GrUB, however. Utilising the action-oriented focus of the game, predator and prey relationships become a means of practicing discovery. By with-holding all the information, but presenting it through a manner that beneficial to the player's success, the discovery element can serve both the reinforce the excitement, but also the factual content contained within the game's memory menu.

Like the Flutterpedia, the memory records the factual content of creatures encountered, but focuses on interactions instead of sets or short facts. Since the interactions are the focus of the play experience, these become the most relevant

content to convey to the player. If another young dragonfly is seen being eaten by some other bug, then the attacking bug is clearly something to be avoided. In the case of a young dragonfly being eaten, this would allow the player realise a threat to their own character, and avoid costly interactions later. It also puts a very small barrier between the gameplay and the information, which potentially encourages memorisation like those observed between the Mission System and Flutterpedia in Flutter.

Observation and reflection through the memory menu is one way of encouraging discovery within gameplay, but could lead to an otherwise passive game. Direct interaction must also be a component, providing the challenge and risk factor. In Flutter, challenge is maintained by the event structure, something that likely would not work for GrUB. Instead, the player should be encouraged by the game mechanics to initiate an interaction, and not punished too painfully for doing so. This would be a careful balance, and can be equated to having extra-lives in standard side-scrollers. Negative encounters can be mitigated by the chance to try again, but is permitted only a limited number of clearly depicted times. These escapes can also unlock information in the memory system, again building a gentle safety-net into that loop to help curb frustration, while maintaining excitement and risk, perhaps even acting as a bonuses to observing an interaction.

Through these systems, the concept of discovery can be linked to the core game loop by requiring players to observe and reflect on the game in order to progress. What players are reflecting on then draws their attention to the factual content, much like how the Flutter Missions draw player attention to facts about butterflies.

H.9. Managing Expandability

As demonstrated through the Flutter event systems, discussed in Chapter 2, GrUB would likely need a means of sustaining interaction which could be expanded over time. This expansion provides avenues for re-engagement, and offers continual challenges to be met by the player. Two common ways of addressing this in casual arcade-styled games are through their replay value, and the unlocking of newly explorable areas or characters. Either of these might prove effective for a game like GrUB. Using the later to match a solution much like Flutter's, new characters could be regularly unlocked on different maps, creating an almost collection oriented theme to the game while allowing players to explore new environments in an attempt collect all the creatures within it. This concept might also work well for the replay situation too, where the same game is played repeatedly, but with harder or more numerous challenges. In these cases, the game would need sufficient challenge to allow players to complete the narrative, without discovering every interaction. In turn, this would be used to draw players back into the beginning of the game, where harder challenges and new characters could be applied.

Another possible solution to the expandability of GrUB would build on the replay concept above, but allow players to take new perspectives through the narrative. In this way, new characters are unlocked at the completion of each game, and discovering their interactions within the same environment becomes the re-engagement draw. To further illustrate this example, consider playing the game as a lone dragonfly the first time but then being given the chance to play it again as a lone salamander, or damselfly, or perhaps even as a mosquito. Each could emphasise different play strategies, and could go as far as exposing the player to new maps as well as new creatures.

Of course, as the studies involving Flutter helped to illustrate, one final approach might be to divert from the stand-alone style, represented by Flutter and other commercial games, in-order to specifically facilitate collaborations with nature centre audiences. Perhaps a more feasible option for nature centres, this idea uses the game as more of a sustained engagement tool while dropping the perpetually expanding content and monetising models. Consider then the nature centre as the hook, and the game as a tool to help cultivate sustained interest while

the visitor or player is away from the institution. A set number of interactions could be created, with the explicit knowledge that the game will wear-off on its audience, hopefully delivering a fun enough experience to have fostered continued interest.

Regardless of the specific approach, expandability is still a major consideration for the game in-order to have a sustained impact. In GrUB, a continually growing cast and the easy addition of levels, are the two most practical ways of dealing with this, although replay from another perspective might prove more engaging to players through simulated testing.