An investigation into the independent design of audio games through the development of the *Audio Game Hub* and *Blind Cricket*

Jarosław Beksa

This thesis is dedicated to visually impaired and blind gamers.

An exegesis submitted to Auckland University of Technology in partial fulfilment of the requirements for the degree of Doctor of Philosophy

Jarosław Beksa
M.Sc. (Warsaw University of Technology, 2009)
B.Sc. (Warsaw University, 2006)

10 June 2020
© Jarosław Beksa

Jak usłyszeć siebie pośród śpiewu tłumu?[1]

How do you hear yourself among the singing of the crowd?

Marek Grechuta

[1] This is a line from the poem *Dni, których nie znamy* by the Polish singer, songwriter and composer Marek Grechuta (1945–2006). The line comprises part of a song written in 1971, during a period when Poland was governed by the Soviet-influenced communist administration (established after World War II). In the work, Grechuta asks how as an independent thinker one might 'hear' oneself in times of indoctrination, when there is an emphasis on convergent thinking.

Abstract

According to the World Health Organization (2019), an estimated 217 million people worldwide are visually impaired and 36 million are blind. Although there are approximately 114,000 video games currently in active circulation (MobyGames, 2020), just over 700 of these are accessible to the visually impaired (AudioGames.net, n.d.-a).

This practice-oriented research project investigates the potential of audio games through the design and development of the *Audio Game Hub* and *Blind Cricket*. The games were created through iterative cycles of prototyping and public releases and stimulated and refined through the agency of voluntary user feedback. They were released on iOS and Android platforms and over a period of two years were downloaded over 130,000 times. They gathered insightful user reviews and won multiple nominations and awards. The project was presented at several conferences and featured on television and the Internet.

The research was activated by a form of agency I define as an Indie Designer/Developer. Here, one is an integrated agent who develops work through critical reflection from online reviews, relying heavily on the implementation of tacit knowing (Polanyi, 1967; Schön, 1984). As a 'generalist', the Indie Designer/Developer combines the role of researcher, designer, reflective practitioner, developer, publisher and entrepreneur.

Keywords: audio game hub, indie designer/developer, interface design, practice-oriented research, visually impaired.

Table of contents

List of figures

Unless otherwise specified, all images in this exegesis are the author's. Where they are not, they are reproduced under section 42 of the *Copyright Act 1994*,[2] which allows for fair dealing with a work for the purposes of criticism or review.[3] Where an image belongs to a third party, copyright ownership and permission has been noted in the caption.

[2] See https://www.pmca.co.nz/About/Copyright.
[3] See https://fairuse.stanford.edu/overview/fair-use/what-is-fair-use/.

List of tables

List of audio samples

List of videos

Attestation of authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the qualification of any other degree or diploma of a university or other institution of higher learning.

Jarosław Beksa, 10 June 2020

Acknowledgements

This exegesis is the culmination of a four-year journey that would have been unimaginable without the ongoing support, input and dedication of my friends, family, colleagues, fellow gaming enthusiasts and numerous other contributors. I would like to take this opportunity to extend my appreciation to the individuals who stayed by my side during this rewarding but challenging journey.

I am particularly grateful for the assistance provided by my supervisors:

- Professor Welby Ings, my primary 'A-supervisor', who took on a true mentoring role in the most challenging final phase of this PhD and contributed to a substantial reshaping of what has become the final thesis. Although he had ample reason to reject the supervision of yet another project (given that he was leading 14 other doctoral candidates), he believed in me, gave me a chance and guided me through the difficult process of writing up the exegetical text.
- Dr Philip Carter, who initially accepted me as a PhD candidate and helped me to obtain a Vice Chancellor's Scholarship. Philip gave me the freedom to explore my own path, set true goals and liberate myself as an Indie Designer/Developer by following my heart and trusting in my intuition.
- Professor Sonia Fizek, my secondary supervisor, for inviting me to join the Gamification Lab at Leuphana University, which served as a catalyst for this thesis. Sonia was my 'sister', looking after me during my time in Germany. She provided unwavering support from the outset, offering contagious enthusiasm, passion and a joyful attitude towards life (and my work).
- Professor Dave Parry, my tertiary supervisor, who offered useful feedback that strengthened this exegesis.

I would also like to offer special thanks to my friends and colleagues who supported me at Auckland University of Technology:

- Jeong Su Jeon, who coded 95% of the games. From the beginning of the journey, Jeong was a friend and a 'family member' on whom I could rely. He always managed to complete projects, never complained (even in the most

challenging situations), was always enthusiastic about new ideas and offered to work on the project pro bono after funding was depleted.

- The *Audio Game Hub* team – Serge Rajinovich, Austin O'Brien, Yiding Liu, David Delgado, Vincent Polewidhi, Juan Alejandro Rodriguez and Alex Garkavenko – for their work, passion, creativity and commitment.
- Mitali Purohit, Professor Stephen MacDonell and Steve Corbett for their constant enthusiasm towards the project and for supporting it both financially and operationally.
- Robert Wellington for providing the *Audio Game Hub* team with office space at Auckland University of Technology.
- Blind Low Vision New Zealand for their generosity in providing office space, a recording studio and support in developing the games. In particular, I would like to acknowledge Sarvajith Ravishankar, Acting Chief Digital and Information Officer, for saving the Sonnar company I established by hiring us as an organisation and allowing us to complete the game *Animal Escape* while working on his contract.
- Media Design School lecturers Jordan Browne, Tece Baryak, Ivan Khmel, Sam Yang and Zac Watson for giving me the space and time to write this exegesis, often relieving me from teaching obligations.
- Auckland University of Technology for awarding me a Vice Chancellor's Scholarship.

In various ways, this doctoral project has been shaped by colleagues with whom I was lucky enough to work with:

- Mathias Fuchs, the head of the Gamification Lab at Leuphana University in Lüneburg, Germany. He provided the necessary infrastructure for the project in the gestation stages of the *Audio Game Hub* and supported me to transition from the role of a researcher at the Gamification Lab to a PhD candidate at Auckland University of Technology in New Zealand.
- David Scheele and Sophie Jent, both of whom worked with passion, creativity and commitment on the coding of the early audio games during my term at the Gamification Lab.
- Krzysztof Majewski who taught me the essentials of corporate work and allowed my ideas to grow and prosper. He encouraged me to trust in my intuition and

afforded me the freedom to develop audio game prototypes at the Polish Telecom Research and Development Centre.

I would also like to extend my thanks to:

- Sara Chin, my partner in life, for supporting me during this challenging period. Her unfailing commitment, patience and attention to detail were integral to the progress of this thesis.
- Anja Kussler, Luke Sniewski and Milena Parobczy for their support in the writing process.

I would also like to express my sincere appreciation to:

- All of the people who supported the *Audio Game Hub* project, including the numerous Kickstarter backers.
- Coisa de Nerd, the Brazilian YouTuber, for the substantial boost he gave to the *Audio Game Hub* via his review.

Finally, I would like to extend my sincere gratitude to all of the blind and visually impaired gamers for their support, feedback and commitment to playing audio games. You are, after all, the very core of this project and the reason why the *Audio Game Hub* and *Blind Cricket* were designed.

Ethics approval and consents

The thesis study did not require ethics approval because in developing the games the project drew on user feedback posted voluntarily to online platforms and the designer/developer's artistic and technical responses to this information.

The research drew on published data from reviews and interviews conducted by the Leuphana University Gamification Lab (2014–2015) and Customer Testing Center, Polish Telecom (2011).

Jarosław Beksa, 10 June 2020

Publications

Beksa, J., Garkavenko, A., Fizek, S., Vodanovich, S. & Carter, P. (2016). Adapting videogame interfaces for the visually impaired: A case study of *Audio Game Hub*. In J. Gołuchowski, M. Pańkowska, C. Barry, M. Lang, H. Linger & C. Schneider (Eds.), *Information systems development: Complexity in information systems development (ISD2016 Proceedings)*. Katowice, Poland: University of Economics in Katowice. https://aisel.aisnet.org/isd2014/proceedings2016/ISDMethodologies/3

Beksa, J., Fizek, S. & Carter, P. (2015). Audio games: Investigation of the potential through prototype development. In P. Biswas, C. Duarte, P. Langdon & L. Almeida (Eds.), *A multimodal end-2-end approach to accessible computing* (pp. 211–224). Springer. https://doi.org/10.1007/978-1-4471-6708-2_11

Fizek, S., Woletz, J. & Beksa, J. (2015). Playing with sound and gesture in digital audio games. In A. Weisbecker, M. Burmester & A. Schmidt (Eds.), *Mensch und Computer 2015 - Workshopband* (pp. 423–429). https://doi.org/10.1515/9783110443905-061

Introduction

1.1 How to read this exegesis

This exegesis is an interactive PDF (Portable Document Format) that allows you to play multimedia files. To access this material, please open your browser. To play an audio file, please click on the icon as presented below or click on the link in the caption (*Audio 1.1*).

Audio 1.1. Audio test sample icon (link). © Jarosław Beksa.

To play a video file, please click on the provided image or the link in the caption which will take you to YouTube.[4]

It may be useful before reading this exegesis to play the games. If you play them with your eyes closed, you may better comprehend the concept of an audio game and experience what it is like to play as a person who is blind. Links to the games are provided in Section 1.7.1.

1.2 Why did I initiate and engage in this work?

Preceding this study, in 2006, during a usability study of an audio game prototype conducted at the Polish Telecom Research and Development Centre, I met Tomek Tworek.[5] He was a blind gamer who, when I questioned him about playing video games, responded with frustration. He complained, 'Nobody makes games for us'. He revealed that the only way for him to play a video game was to ask his sighted sister to play the game under his instruction. However, this relied on his sister's availability and he wanted to play independently.

[4] YouTube is an online video-sharing platform.
[5] During this period, I was involved in a research project, *Usability study of audio game: Adventures of Jolan*, that motivated this thesis. The study was conducted by the Polish Telecom Customer Testing Centre and the results were published internally in 2007 (Szewczyk-Biedrzycka et al., 2007).

During that year, I identified and played most of the audio games on the market. To my surprise, there were very few, and in my opinion even fewer of good quality. By 2019, there were approximately 114,000 video games in active circulation (MobyGames, 2020) but only around 700 of these were accessible to visually impaired users (AudioGames.net, n.d.-a) (see Figure 1.1). Being much simpler than their video counterparts, many audio games were not developed with the same depth, diversity, quality or level of replayability. I saw this as an unmet need and felt a responsibility to provide visually impaired users with gameplay of a higher quality than that currently available.

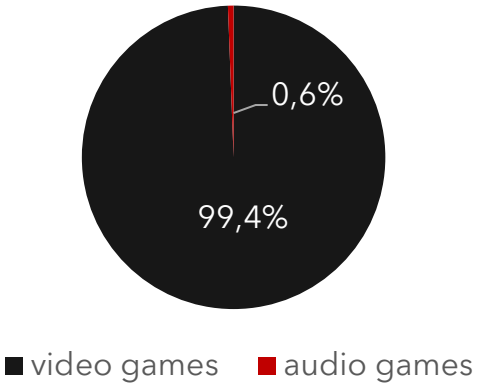


Figure 1.1. Video and audio games as a proportion of total computer games available in 2019. © Jarosław Beksa.

The lack of variety and quality in existing audio games not only affected Tomek. According to the World Health Organization (2019), an estimated 217 million people worldwide are visually impaired and 36 million people are blind. That is around 3.3% of the world's population (Bourne et al., 2017).

Playing video games was a significant part of my early childhood; I derived considerable joy from playing in well-designed environments. The limited variety and poor quality of audio games that Tomek and people like him were restricted to struck me as unfair and prompted me to consider how accessibility and a quality gaming experience may be successfully integrated for visually impaired and blind gamers.

1.3 Prior research

The *Audio Game Hub* project began in January 2014 at the Gamification Lab of Leuphana University in Lüneburg, Germany. The initial study involved the development of eight audio game prototypes and a usability study with sighted and visually impaired gamers. The *Audio Game Hub* prototype was introduced to, and tested on, two groups of sighted players (heavy and casual gamers) and one group of visually impaired players. During 60-minute test interviews, participants were observed while playing the games and were able to give detailed feedback regarding aspects of the user interface, game mechanics, sound quality, perceived immersion and overall enjoyment of each game.

The project was completed with the publication of the usability study report (Woletz, 2015)[6] and project results (Fizek et al., 2015).[7] This usability study report predated my doctoral project and is not part of this thesis (see Figure 1.2). When the project ended, I had a set of games that still needed further development and began thinking about how I might refine these and develop new games without using conventional methodological approaches. During my PhD, I explored the concept of an Indie Designer/Developer who draws on data (both in published reports and unsolicited online postings) to refine and design audio games.

[6] https://www.slideshare.net/juliewoletz/media-uselab-studienauswahl.
[7] https://rke.abertay.ac.uk/en/publications/playing-with-sound-and-gesture-in-digital-audio-games.

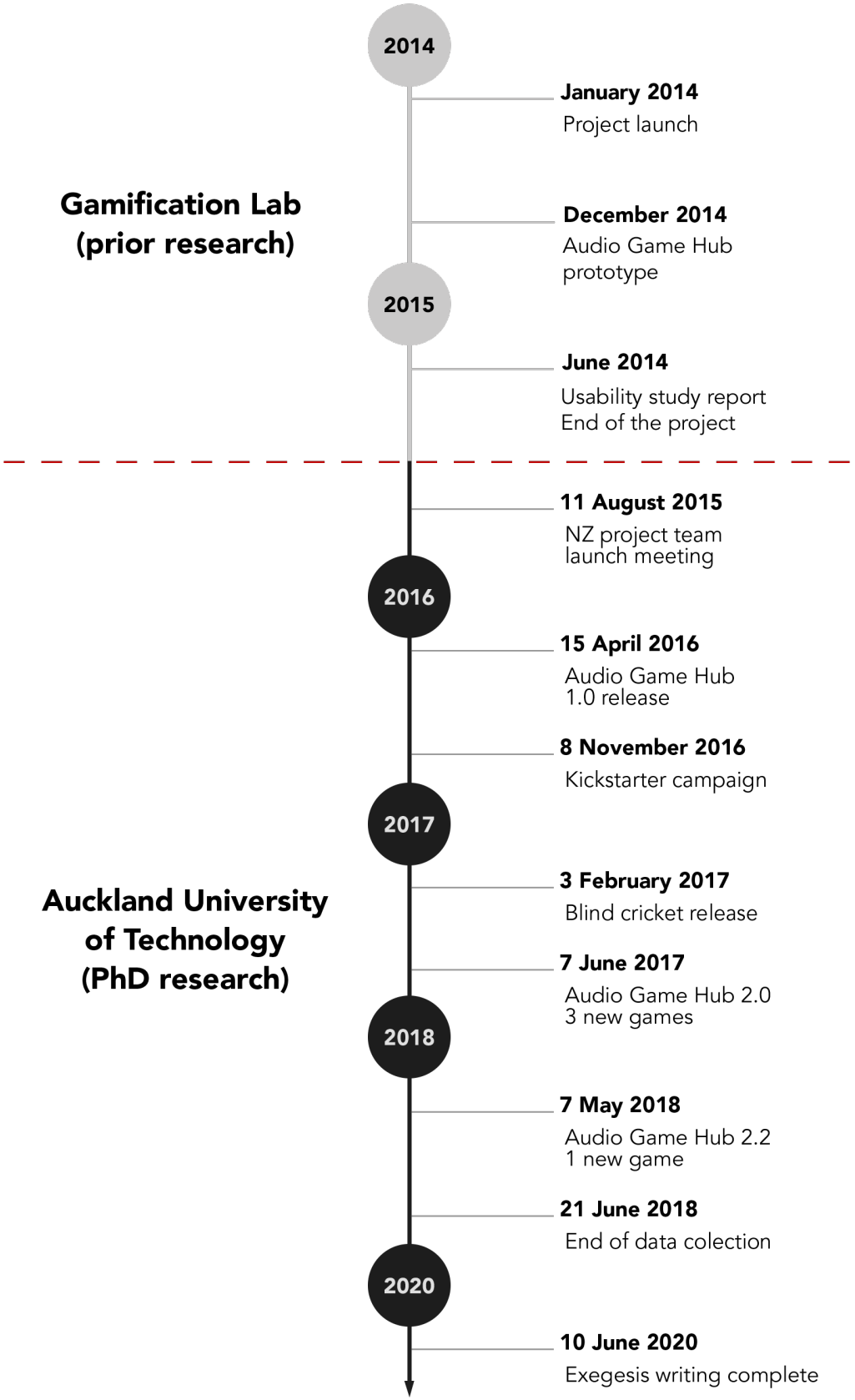


Figure 1.2. Timeline of this PhD project and prior research conducted at the Gamification Lab, Leuphana University with significant milestones shown. © Jarosław Beksa.

1.4 Research question

This research was guided by a question that was refined as it progressed:

> How can games for people with visual impairments be designed, developed and refined through the use of iterative online feedback by an Indie Designer/Developer who operates outside of conventional game design methodologies?

1.5 Objectives and contributions

This thesis had two primary objectives. The first was to create a set of accessible audio games for visually impaired and blind people.[8] I sought, through practice-oriented inquiry, to explore the extent to which a sighted independent designer/developer might be capable of creating games for people with vision loss and whether non-sighted gamers would be able to resonate and engage with my subjective interpretation of their realities. The second objective was to consider a model for game development where a developer/designer works as an integrated reflective practitioner who draws on online feedback and high levels of tacit knowing.

The thesis contributions are presented in two ways: an exegesis and artefacts (*Audio Game Hub 1.0* and *2.0* and the game *Blind Cricket*). The exegesis considers the context of the inquiry, research design underpinning its development and critical ideas impacting on and emerging from the study. It is anticipated that this research might usefully contribute broader understandings to both the indie game industry and accessible game development. The games (artefacts) increase the variety and number of available accessible audio games. There are elements of novelty in the interface and game mechanics design. It is also anticipated that the *Audio Game Hub* may increase awareness of the needs of people with disabilities and may inspire other game developers to create better and more accessible games.

[8] 'Visual impairment' is a general term describing a wide range of visual function, from low vision to total blindness. 'Visual impairment' refers to visual acuity worse than 20/70. 'Total blindness' describes complete lack of form and light perception (AFB, n.d.).

The research also contributes to ways of thinking about methodology. Thus the study discusses and applies the concept of an Indie Designer/Developer (Daglow & Ismail, 2018; Juul, 2019; Michael, 2003; Perez, 2019). This particular approach enabled me to design and develop games based on being a reflective developer/designer/practitioner, drawing on voluntary online feedback and high levels of tacit knowing. Given that an increasing number of game designers operate as independent agents outside of AAA companies, this research may offer a useful case study that highlights and reflects on the nature, advantages and challenges of such an approach.

1.6 Key terms

This section defines key terms used in the exegesis.

1.6.1 Audio game

Audio games are designed to be accessible to a broad audience of players, including people with visual impairments. They constitute a special genre of computer games that use audio as a primary interface. Unlike video games, they can be played with the screen turned off because visual components are unnecessary for the game experience (Friberg & Gärdenfors, 2004).

1.6.2 Indie Designer/Developer

For the purposes of this thesis, I use the term 'Indie Designer/Developer' to describe a single game developer or a small team that embodies two types of independence:

- they provide or generate independent funding, self-publishing and self-distribution
- they are vision driven; that is, they often reject mainstream game conventions such as the heightened emphasis on monetarisation.

The principles of Indie Design/Development were identified during the process of producing the games. Thus, both the theory and framework emerged from the process of designing; rather than appearing as a prefiguring device for the study.

David Michael (2003) suggests that an Indie Designer/Developer is a person who possesses passion, pace and perseverance. He suggests that passion provides the initial spark, arguing that it is very often the dream of making games or the need to create a unique game of one's own that ignites this drive. Pace and perseverance are qualities that he suggests enable the game development to be completed, despite the fact that the designer/developer may be working without an established roadmap.

Rebekah Valentine (2018) suggests that an Indie Designer/Developer is often a 'generalist'. Benek Lisefski (2019) likens such a practitioner to a 'Renaissance man' who possesses a wide array of skills and knowledge and performs multiple tasks in a project. He suggests that such a developer can be distinguished from a traditional game development 'team member' who exercises a narrow specialisation in a specific domain.

Enrique Perez (2019, p. 168) argues that 'the design of indie games is more akin to an artistic practice'. In this context, the design of indie games is often more concerned with creativity, freedom and expressiveness than monetisation or marketability.

1.6.3 Tacit knowing

The term 'tacit knowing' is attributed to Michael Polanyi and was described in his book *The tacit dimension* (1966). Polanyi suggests that 'we know more than we can tell' (1966, p. 4). He claims that not only do people possess knowledge that cannot be adequately verbalised, but all knowledge is rooted in tacit knowledge. Donald Schön, in his book *The reflective practitioner* (1983), describes tacit knowledge as 'knowing-in-action' and states that the only way to acquire such knowledge is through experience. Gilbert Ryle (1945) associates this form of knowledge with 'knowing-how' as opposed to 'knowing that'. Ritesh Chugh (2015) defines tacit knowledge as experiences, skills and ideas that people have but which are not organised and may be difficult to express. However he argues that people are often aware of this knowledge and how it can be of value to others.

In this thesis, I exercise tacit and explicit knowing, both of which are built from the accrual of experience. 'Tacit knowing' is a term I use to describe an intuitive sense of knowing 'rightness' in decision-making and forward movement in my design practice (Nepia, 2012).

1.6.4 Practice-oriented research

Practice-oriented research is a form of academic inquiry situated within practice. According to Linda Candy (2006, p. 1), there are two types of practice-oriented research:

- **practice-based**, when a creative artefact is the basis of the contribution to knowledge
- **practice-led**, when the research leads to new understanding about the practice.

She suggests that 'Practice-based Research is an original investigation undertaken in order to gain new knowledge partly by means of practice and the outcomes of that practice' (p. 1). She argues that in such instances, although a contribution to knowledge may be described in words, full understanding can only be obtained through creative outcomes in forms of designs, music, digital media, performances or exhibitions. Conversely, practice-led research is focused on the nature of the practice and leads to new knowledge about that practice. She suggests that such research can be fully described in text form and does not require creative output.

While appreciating these demarcations, I prefer to consider a wider concept of practice-oriented research – research that is oriented towards and realised through practice. Within this, an inquiry may move on a continuum between, and incorporate elements of, both practice-led and practice-based research. Practice-oriented research may be broadly understood as research concerned with the pursuit of effective or novel outcomes (be they iterative or final) where the researcher 'comes to know' through practice. This coming to know requires reflection on both the research process and outcomes of one's practice.

1.7 Thesis structure

This thesis consists of two parts: the artefacts (audio games) and an exegesis in which the context, research design and critical concepts underpinning the project are discussed.

1.7.1 The practice: artefacts

There are two groups of artefacts. The first group contains eight prototype games refined using the Indie Designer/Developer model and included and published in *Audio Game Hub* version 1.0:

- *Archery*
- *Hunt*
- *Memory (Animal Farm)*
- *Samurai Tournament*
- *Samurai Dojo*
- *Labyrinth*
- *Blocks*
- *Slot Machine*

The second group contains five games designed and developed entirely using the Indie Designer/Developer model. The artefacts consist of four additional games contained in the *Audio Game Hub* version 2.0:

- *Blackjack*
- *Animal Escape*
- *Bomb Disarmer*
- *Super Simon*

The practice also contains a separate game, *Blind Cricket*, developed the same way as the *Audio Game Hub* version 2.0 games, but published independently due to the large file size.

The games have been released on iOS and Android platforms and can be downloaded from the project website (www.audiogamehub.com) or accessed at the following application stores:

- ***Audio Game Hub* version 1.0:**
    - PC Windows: http://www.audiogamehub.com/wp-content/uploads/2016/05/AGH_Setup_1.1.6.exe
- ***Audio Game Hub* version 2.0:**
    - Apple Appstore: https://itunes.apple.com/us/app/audio-game-hub/id1101972684

    - Google Play Store: https://play.google.com/store/apps/details?id=com.AUT.AudioGameHub
- *Blind Cricket*:
    - Apple Appstore: https://itunes.apple.com/us/app/blind-cricket/id1198892910?mt=8
    - Google Play Store: https://play.google.com/store/apps/details?id=com.Sonnar.BlindCricket&hl=en

1.7.2 The exegesis

The exegesis contextualises the study. In scholarship, the word 'exegesis' was originally associated with theological writing that sought to 'explain' or offer a 'critical interpretation' of an idea (Soanes & Stevenson, 2008, p. 498). Jeri Kroll (2004, p. 4) suggests that in practice-oriented theses the exegesis constitutes a form of written 'authorial announcement … where writers reveal their personalities as well as their methodologies'. Such a document, Jillian Hamilton (2011, para. 2) suggests, requires a reconciliation between 'the disinterested perspective and academic objectivity of an observer/ethnographer/analyst/theorist [and] the invested perspective of the practitioner/producer'. In pursuit of this idea, this document is structured into seven chapters.

Chapter 1 constitutes an introduction to the study.

Chapter 2 offers a positioning of the research and researcher. In this chapter I discuss my background in gaming and development of the qualities of an Indie Designer/Developer.

Chapter 3 presents an overview of research impacting on or contextualising the inquiry. It considers the nature and evolution of audio games including their current status. It discusses audio game design guidelines and concludes with a review of the evolution of thinking relating to the concept of an Indie Designer/Developer.

Chapter 4 considers the research methodology employed in this study. Beginning with a consideration of practice-oriented research, it examines the nature of heuristic inquiry. It

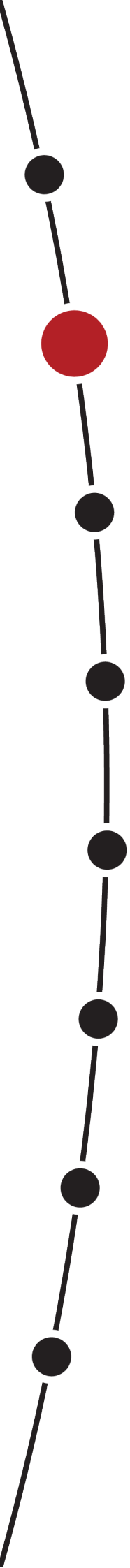
then unpacks the process of the research and applied methods through four phases of implementation. The chapter concludes with a critique of the methodology.

Chapter 5 examines the application of indie design and development by considering the project's approaches to team building, securing funding, development publishing, marketing and monetisation.

Chapter 6 is concerned with the games themselves. It offers a brief description of each artefact and relates specific games to critical ideas that surfaced during the research.

In concluding the exegesis, I summarise the main ideas in the study and reflect on my practice. I then consider the project's contribution to the field and possible directions for further research.

The exegesis contains seven appendices.
The first provides the *Audio Game Hub* prototype usability study results.
The second contains the *Audio Game Hub* examples of games flow design.
The third provides a crowdfunding workshop report.
The fourth contains the games' user feedback.
The fifth provides the *Audio Game Hub* and *Blind Cricket* results.
The sixth contains the game's change log.
The seventh provides the games' credits.
The eighth provides the individual team members' contributions.



Positioning the researcher and research

2.1 My childhood and background

I grew up in Poland during the 1980s, when it was still an Eastern Bloc country under communist rule. My childhood revolved around living in a small apartment in a prefabricated block of concrete flats, spending time outside or in front of a television set with only two channels available. I owned very few toys.

It was video games that painted my life with colour. In 1989, my older brother received his first computer machine, an ATARI 65XE. I was mesmerised by it and drawn into the world of digital fantasy. I became addicted to video games.

During my childhood, video gaming mechanisms and the way they were delivered was different from today. Rather than streaming and downloading files from the Internet, video games for the ATARI 65XE were distributed in the form of magnetic audiocassettes (Knight, 2015). Some games required more than two hours of loading time and access to these games was often very limited. However, it was possible to copy a game using a blank cassette and a typical double-dock audio system with recording capability. There were even radio auditions where whole games were transmitted through FM radio signals, although the legality of such practices was questionable (Radziewicz, 2015).

Sluggish technology and difficult access did very little to deter my fascination and involvement with video games. My brother and I would spend hours in front of the screen. Only when my mother unplugged the system did our digital adventures come to an end for the day. When not playing, I was recording the 8-bit audio tracks from the video games to listen to them on my Walkman (Franzen, 2014). To me, video games opened up a world of infinite possibilities and permutations. The non-linear plots of video games introduced the excitement of exploring new worlds and immersing myself in the characters of a game. It appeared that the only limitation to reality in the world of video games was the player's imagination.

After my parents bought us our first gaming console, I committed every penny I could save towards upgrading my video game experience, including buying a Nintendo Entertainment System (NES) console (Cunningham, 2013) and later my first Personal Computer (PC)[9]

[9] Intel 486SX model.

(Knight, 2014) with Disk Operating System (DOS). Despite this commitment, I found balance in my life through my second passion, sports. Running cultivated useful character traits, such as perseverance, determination and willpower. It also offered me a way to compete with others. Attending the Warsaw School of Sports Excellence (high school), I developed a systematic approach to excelling in academics and sports. This helped me to obtain a full sports scholarship. My daily routine involved six to eight hours of studying and two to three hours dedicated to training and sports-related activities at the Warsaw Sports Academy. The heavy emphasis on productivity meant I had to be a master of time management to excel. The only time I could play video games was on weekends.

At school, I stumbled on yet another passion, music. It seems to be a theme in my life that when I find something I like, I become completely invested in it. Instead of becoming a casual collector of audio tracks and connoisseur of musical knowledge, I made it my mission to deconstruct the essentials of music so I could create my own. First, I learned how to use audio editing software such as Cool Edit and Logic Audio. This enabled me to mix and create my own compositions. At the age of 16, I became a professional DJ and played regularly at a local club in Działdowo. A number of my mixes were played on the Polish radio station Radio Dla Ciebie (RDC). Video games and sports served as entertainment, but my involvement in audio and electronic music awakened my creativity and provided me with an avenue to express myself. On the surface, video games, sports and music may seem like unrelated interests, but not only did these activities consume my waking hours, they also built a foundation of knowledge and experience that would soon become important after I encountered a personal tragedy.

Objectively, I was a promising athlete. However, my dreams of winning Olympic Gold were abruptly crushed when I sustained a serious knee injury just prior to the Polish National Championships in 1998. This resulted in three subsequent surgeries and an end to my sports career. Having lost my purpose, I needed to find new ways of making my life meaningful. It had never been my intention to pursue academic study, but with my athletic pathway suddenly rendered unfeasible, I enrolled in Computer Methods of Physics at Warsaw University.

After my first year of studying physics, something unexpected happened; I fell in love with science. I realised that I could achieve much more by using my brain than using my muscles. Slowly it became evident that the knee injury I had considered a curse was actually a

blessing. Here I was exposed to various mathematics, physics, computer programming, electronic engineering and critical thinking courses. I was also fortunate enough to be able to visit the Hadron-Electron Ring Accelerator (HERA) in Hamburg, Germany, where I completed my first research internship. Throughout this time (from sports and music through to the end of my physics studies), video games remained a loyal companion. I played a lot, and these experiences had a profound impact on my functioning as an Indie Designer/Developer and shaped my future professional and academic career.

2.2 Professional background

2.2.1 Internship at Multimodal User Interfaces Laboratory

Immediately after earning my bachelor's degree in Physics in 2006, I undertook a summer holiday internship at Polish Telecom's Research and Development Centre. The internship was focused around automated speech recognition (ASR) (Yu & Deng, 2015) and text-to-speech (TTS) synthesis (Xian-Yi & Yan, 2011). During the first three months, I learned the basics of the VoiceXML (W3C, 2004) programming language and developing interactive voice response (IVR) services. My first project was a voice application titled *Automated Phonebook* which used voice recognition and speech synthesis as its interfaces. I completed the project before the expected deadline and utilised the extra time to experiment with some of my own ideas. I created different types of 'phone' applications such as quiz games, virtual dates and pizza ordering.

During the last month of my internship, one of my work colleagues was playing a video game intended for blind users called *Cosmic Darts* (Klango, 2005).[10] The concept of using sound to create a video game experience captivated me. This was the first time I had experienced gaming without a visual interface. I began thinking of ways in which voice technologies could be used to develop games and immersive experiences for blind users. My supervisor, Krzysztof Majewski, liked the concept and encouraged me to submit a proposal for a full-time job based on the development of these ideas. Reflecting on my experience, I consider this as the moment that I became inspired to explore an academic and professional career in audio games.

[10] This game is no longer available.

2.2.2 First audio game prototype

During the recruitment process, I began my Master of Sciences at Warsaw University of Technology where I majored in Computer Engineering in Medicine. I found this study interesting yet much easier than Physics. Four months later, Polish Telecom accepted my proposal and I began a six-month fixed-term contract to work on audio game ideas. Working and studying full time was challenging. The first months here were the hardest, but probably the most productive in my life.

I initially undertook an examination of the audio games market. I did this by locating and playing the most popular audio games available (approximately 30 games). Most were poor-quality arcade games that had been produced mainly by university academics and researchers.

One of the games I played, *The Last Crusade* (Dweyer & VanLund, 2004b), had a significant impact on my future work. This was an interactive story that included elements from traditional role-playing games (RPGs). The game had no visual interface and user involvement existed entirely in the realm of sound. *The Last Crusade* came with a map editor and source code that allowed me to modify the game and perform my first usability study. I invented a new storyline, recorded dialogues and designed sound effects. The new audio game prototype was called the *Adventures of Jolan* and it formed a basis for a usability study with sighted and non-sighted users. The study was facilitated by the Customer Testing Centre and the results were published in Polish Telecom's Internal Report (Szewczyk-Biedrzycka et al., 2007).[11] Initial findings were very promising and prompted me to progress with my inquiry.

To increase my chances of being hired, my manager suggested that I submit my audio game idea (supported by the usability study results) to *Telekreator*, Polish Telecom's internal innovation contest. Despite going up against impressive projects like optic fibre data transfer optimisation algorithms, which were estimated to save Polish Telecom millions of dollars, I became the first intern to win the first prize of 25,000 PLN (approximately 10,000 USD at the time). I received a full-time contract offer shortly thereafter.

[11] The detailed study results were published internally at Polish Telecom. A summary of the results can be retrieved from http://www.aes.org/e-lib/browse.cfm?elib=15763.

The Research and Development division of Polish Telecom was considered one of best places to work in Warsaw, and due to its innovative approach, drew comparisons to companies like Google. It took me a few months to acclimatise myself to the new corporate landscape; meeting people, learning corporate language and the appropriate corporate channels of communication, as well as understanding the company's standard operating procedures. In this environment, I developed new soft skills like leadership and personal accountability. I had the freedom to explore my ideas and the support necessary to bring these to realisation. I was also able to attend the largest gaming conference in the World, the Game Developer's Conference (GDC) in San Francisco, California.

2.2.3 *1812: Heart of Winter*: an interactive audiobook

While working at Polish Telecom, I came across the Audiomostly conference proceedings of a group of researchers who introduced the idea of interactive audiobooks (Huber et al., 2007).[12] Inspired by this concept, I began working on Poland's first interactive audiobook (Kołyszko, 2011). To acquire a game story, our team organised a contest (Wasilewska-Śpioch, 2008). The first prize was 10 000 PLN (approximately 4,000 USD at the time)[13] and information about the contest was promoted by most national internet media (e.g. Wirtualna Polska). This resulted in over 34,000 contest webpage views and over 130 submissions. The winning story was titled *1812: Heart of Winter*, written by Maciej and Magda Reputakowscy.

The biggest challenge I faced in this project was securing sufficient funds to begin production. This was first time that Polish Telecom had undertaken development of a video game and there was considerable resistance from directors and members of the board.[14] After a considerable struggle, I managed to secure 500,000 PLN (approximately 200,000 USD at time) from other projects that had been abandoned.

In terms of the project's size and scope, *1812: Heart of Winter* was a 'super production', involving 36 voice actors (including Polish actors Piotr Fronczewski and Jarek Boberek),

[12] I was first introduced to the concept of interactive storytelling during my childhood, when I read a series of game books called *Choose your own adventure*. I was fascinated by the notion of non-linear storytelling and the possibility of interacting with, or within, a story.
[13] 1 USD = 2.27 PLN as at 1 September 2008.
[14] When a lack of funding temporarily stalled the project, I busied myself with my first start-up company, Fachowcy.pl, which I sold in 2010. To facilitate the establishment of this venture, I changed my full-time contract to part time.

more than 60 minutes of originally composed music (by Marcin Przybyłowicz[15]) and over 1,000 original sound effects. Within 15 months, our eight-person team[16] had created a custom interactive audio story engine and story editor (see Figure 2.1).[17]

Figure 2.1. Screenshots of *1812: Heart of Winter*. From the left: the main menu, dialogue screen and map of the world screen. Screenshots by the author.

Unfortunately, nine months before its planned public release, our project was cancelled due to budget cuts and the company rebranding itself.[18] I attempted to save the project, including approaching the CEO of our organisation, but to no avail. Eventually, I secured permission to release one-third of the story. Despite our marketing budget being frozen and having to organise the official launch and media release ourselves, *1812: Heart of Winter* was finally published in November 2011 on Windows, Android and iOS platforms. The game was downloaded over 60,000 times and gathered excellent user reviews (on average 4.5 stars out of 5 in App Store).[19] It also received the following awards (Orange Labs, 2014):

- Best Game (Szczecin Game Show 2011)
- Best Dubbing in a Polish game nomination 2011, by Dubscore.pl portal
- Best Game of October by Appdnia.pl
- Ranked #1 in the Polish App Store in the Books category for several weeks.

[15] Marcin later went on to compose music for the acclaimed video games *The Witcher 2* and *3* (CD Projekt, n.d.).
[16] Rafał Sadowski, Paweł Czyżak, Paweł Barszcz, Justyna Gromada, Krzysztof Majewski, Michał Czapski and Konrad Kabaja.
[17] More information on this project can be found in the project description published in 2011 (Beksa, Majewski & Sadowski, 2011), available at http://www.aes.org/e-lib/browse.cfm?elib=15763.
[18] Polish Telecom became Orange (French Telecom).
[19] Data collected through Apple Appstore, Google Play Store and Google Analytics.

1812: Heart of Winter was fully accessible to blind and visually impaired players and received the Certificate of Accessibility from the Polish Blind Association. Today, it can still be downloaded at www.sercezimy.pl.

In addition to the application, a classic version of the audiobook was created and distributed by the largest audiobook retailer in Poland, Audioteka.pl. It was also formatted as a hardcopy (boxed) version by the publishing house Agoy.pl.

For over a year, I tried to find a way to promote the project and raise funds to release the complete story. My efforts included organising events such as a gameplay at the cinema, where the audience could vote and decide on the protagonist's action together (Multikino, 2013), and interactive radio auditions at the Polish Radio Channel 4 (Polskie Radio, 2012), where the audience voted using text messages (SMS). I also tried to find sponsors within and outside of Orange. At one point, I contacted J. K. Rowling and proposed using the *1812: Heart of Winter* concept to create an interactive version of *Harry Potter*. I was pleasantly surprised when I received an invitation to meet her agent Neil Blair (Chairman of Pottermore) and Charlie Redmine (CEO of Pottermore) in London. They liked the idea, but the author did not want to re-write the *Harry Potter* series to serve the potential of this trajectory.

The difficulties experienced while working on *1812: Heart of Winter* strengthened my tenacity and courage. At the beginning of 2013, I was still working for Orange, but I had already begun developing my own mobile applications for children (e.g., *Karaoke for Kids* and *The Turnip*). I took out a bank loan (of 140,000 PLN, approximately $45,000 USD at the time) to hire programmers and graphic designers and formed my second start-up.[20] I also began looking for doctoral environments that might support my research interests.

2.2.4 Doctoral inquiries

In mid-April 2013, I began sending applications for PhD studies and scholarships to universities in Hawai'i and New Zealand.[21] After submitting the appropriate documentation,

[20] 'Start up' refers to a newly established business founded by one or more entrepreneurs who want to develop a product or a service (Grant, 2020).
[21] The universities were University of Auckland, Auckland University of Technology, Victoria University of Wellington, University of Otago and University of Hawai'i at Mānoa.

I was granted admission to Auckland University of Technology. Because of the delay in securing a scholarship, in August 2013, I left Orange Labs and focused temporarily on my start-up and apps for children.[22]

In November, Dr Sonia Fizek, who worked at the Gamification Lab at Leuphana University in Lüneburg, informed me that they were looking for project ideas and game designers and there might be an employment opportunity in Germany for 15 months. I proposed the idea of developing audio games and it was accepted.[23]

Around this time, I also received notification that I had been awarded a Vice Chancellor's Scholarship at Auckland University of Technology. In December 2013 (during winter holidays), I travelled to New Zealand to see if I liked the country, people and atmosphere, and to meet my initial supervisor, Dr Philip Carter. I fell in love with New Zealand and agreed with Dr Carter that I would start my PhD studies after completing the project at the Gamification Lab in Germany.

2.3 The Gamification Lab

My previous experience suddenly became relevant and useful. The head of the Gamification Lab, Professor Mathias Fuchs, gave me an opportunity to work on my own project and provided me with all of the necessary resources. Two full-time developers (David Sheele and Sophie Jent) were also hired to assist me. We also purchased the Pro Sound Effects Master Library[24] (which contained over 100,000 sound files) and sound recording equipment.[25]

Initially, I began creating a text-based RPG, similar to *Zork* (1977).[26] However, after a few weeks, I started developing a hub containing several casual games for visually impaired users. This decision was based on the game scope – a *Zork*-like game would be too large a project to complete in one year, and building several games gave us the opportunity to experiment with different user interfaces and game mechanics. This approach was also

[22] http://www.bajkoteka.pl.
[23] Initially, I was employed as a contractor for three months with the possibility of becoming a full-time employee.
[24] https://www.prosoundeffects.com/master-library/.
[25] Zoom H6 voice recorder and Behringer C1 microphone.
[26] In this regard, it was similar to one of the prototypes my team had created at Orange.

safer in case we experienced delays. If this occurred, the contingency was to release fewer games.

To create the *Audio Game Hub* prototype*,* we used the Unity 3D engine (Unity Technologies, 2017). There were two main reasons for this:

- it was multiplatform, meaning that we could (theoretically) cover PC Windows, Android and iOS platforms with one code
- it offered a fast and easy way to developing games (Menard, 2011).

Although we were a team of only three people, we attempted to implement the Agile Scrum methodology (Keith, 2010; Schwaber & Beedle, 2001) in this project. To maximise the time devoted to development of the *Audio Game Hub* prototype, we chose not to create a formal documentation; instead, we sought only to keep the important parts of the code properly documented and explained.

Each game idea was prototyped on paper and then discussed within and outside of the team. Our approach was to first create a playable demo and perform a usability study on our team members and people in our office. After several iterations, we would lock the current development and proceed with another game. Using this approach, working game by game, we continued to create the *Audio Game Hub* prototype. Along the way, we had to make occasional pivots, especially when we realised that our assumptions were wrong (e.g., when we discovered that a game was not playable while blindfolded, or feedback from real users showed that they were struggling with the interface).

The first visual interface prototype used simple shapes, high contrast elements and fonts (see Figure 2.2).

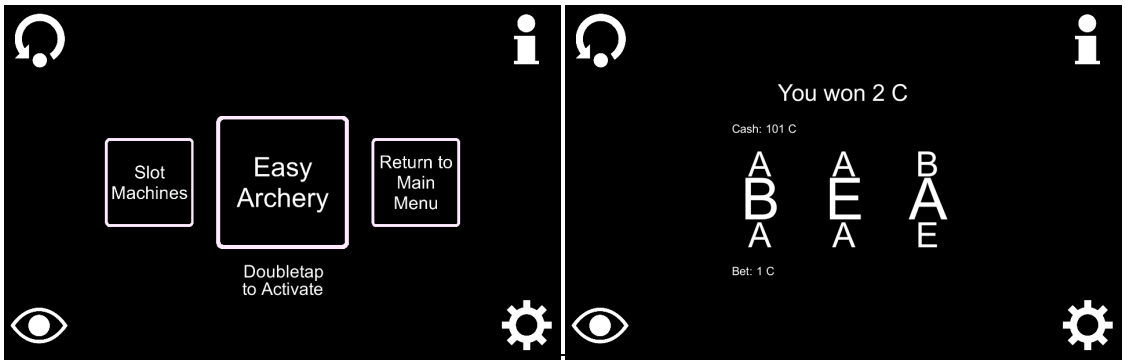


Figure 2.2. *Audio Game Hub*'s first prototype screens. Main menu (left) and *Slot Machine* game (right). Screenshots by the author.

The final graphical user interface was created by Laleh Torabi (see Figure 2.3).

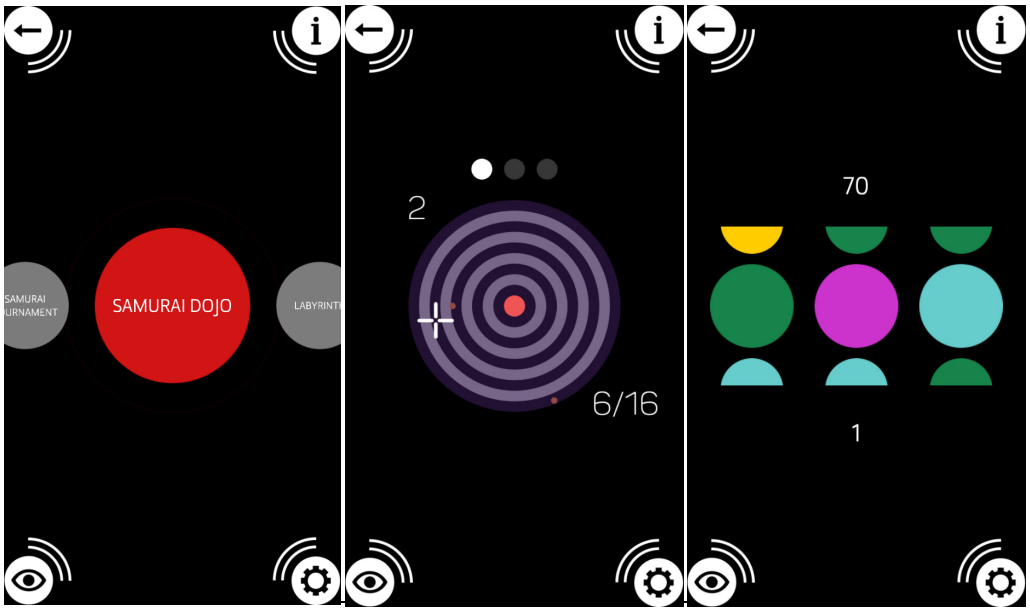


Figure 2.3. Final version of the graphical user interface of the *Audio Game Hub* prototype. From the left: Main menu, *Archery* game screen and *Slot Machine* game screen. Screenshots by the author.

For prototyping purposes, we recorded all dialogues in-house. To diminish the echo while recording, we initially used an acoustic diffuser screen and blanket, but this set-up was very inconvenient for the voice actor, especially in the hot European summer. To solve this problem, we created a provisional recording booth, consisting of two tables and blankets (see Figure 2.4).

Figure 2.4. David Scheele during a voice recording session (left), covered with a green blanket (middle) and a provisional recording booth made of vertically placed tables and blankets (right). © Jarosław Beksa.

Audio 2.1. David Scheele's voice recordings samples (link). © Jarosław Beksa.

In September 2014, we arranged for a professional voice recording session at the Creative Sound Conception Studio[27] in Hamburg, Germany. We attempted to keep the storylines, instructions and tutorials short, simple and precise. Each of the games, as well as the game menu, had a separate voice actor so we could increase the sense of individual character in the work. We sent the descriptions of each character to the production manager and auditioning cast so we could contract the most effective sounding actors. There were over 1,000 voice files in total and each voice feedback was a separate file (menu element, button, sentence, etc.). We purchased the music and sound effects for the *Audio Game Hub* from Envato Market,[28] Unity Store[29] and the Pro Sounds Effects Master Library.[30]

After implementing voice recordings, the games and main user interface were preliminarily tested by both sighted and visually impaired players (Fizek et al., 2015). Feedback enabled us to improve the user interface and game mechanics of these early game iterations. The outcomes of the research were useful because they provided a substrate from which I could draw on as I embarked on my PhD studies.

The *Audio Game Hub* project at Gamification Lab was completed with the publishing of the usability study report (Woletz, 2015)[31] and the results were summarised and discussed in an article by Fizek et al. (2015) (see Figure 2.5).[32]

[27] http://csc-studio.de.
[28] https://audiojungle.net.
[29] www.assetstore.unity3d.com.
[30] https://www.prosoundeffects.com/master-library.
[31] https://www.slideshare.net/juliewoletz/media-uselab-studienauswahl.
[32] https://rke.abertay.ac.uk/en/publications/playing-with-sound-and-gesture-in-digital-audio-games.

Figure 2.5. The Gamification Lab team. From the left: Niklas Schrape, Sonia Fizek, David Scheele, Sophie Jent, Laleh Torabi, Fabian Lehman, Jarek Beksa, Mathias Fuchs. © The Gamification Lab, Leuphana University Lüneburg.

2.4 On the threshold of the doctorate

I returned to New Zealand in February 2015 and began my doctoral studies. I was appreciative of a plethora of experiences that have shaped my attitudes to design. I also held in my hands a set of unfinished games, the results of an initial testing project and the vision for another way of working.

I have never been heavily influenced by convention. I look for opportunities and ascertain ways in which ideas can be realised effectively. Although I have utilised Agile Scrum methodologies and university-facilitated user-centred processes of testing, I wondered if there might be another way of progressing game design. When investigating some of the entrepreneurs who populate areas of the game industry, I observed that many are complex, multi-talented individuals who, rather than separating and farming out practice and knowledge, place emphasis on establishing bridges between ideas and processes. They utilise heuristic approaches to connect not only game design but also its funding, refinement and distribution. These are protean, independent designers/developers that theorists describe as 'generalist' (Valentine, 2018) or 'renaissance thinkers' (Lisefski, 2019). Many of them are highly attentive to feedback that is voluntarily posted online from users

who comment on iterations of their designs. These designers/developers exercise a diverse range of skills and knowledge and are highly dexterous intellectually and professionally.

Although I enjoy working with large research teams, my background in athletics and as an instigator of start-up initiatives had shown me the potential and conditions of singular or small group pursuits. I began asking myself if there was another way that games for people with visual impairments might be designed, developed and refined through a process of iterative online feedback. As a practitioner, I wondered if a multi-skilled generalist might posit an alternative to conventional thinking regarding the way games are designed. I sensed that such a designer might be highly connective; a thinker driven by tacit knowing based on accrued experience and high levels of reflective responsiveness to the critique of his designs offered by online users. My thesis was shaped around these ideas.

Review of contextual knowledge

This chapter offers a review of knowledge relating to the inquiry. Given the thesis's practice-oriented nature, the project draws on knowledge that includes academic literature, information in technical reports and online resources. Accordingly, rather than being a literature review, the chapter is a review of contextual knowledge.

I first provide an overview of the nature and evolution of audio games. I then review audio game design guidelines, followed by a consideration of academic literature in the field and research and development that has contributed to the design of audio games. I conclude the chapter with a discussion of recent literature related to the phenomenon of the Indie Designer/Developer.

3.1 Audio games

Audio games exist in the world of sound and are a special genre of computer games. Unlike video games, they do not require a visual interface; we can play them with the screen turned off. In audio games, gameplay relies primarily on audio cues so sound becomes the dominant interface. The visual components are largely ornamental and not necessary for the game experience. Sometimes, audio games, in addition to audio and visual interfaces, can also use haptic feedback. The most popular community website, Audiogames.net,[33] currently lists over 700[34] games accessible to visually impaired users (AudioGames.net, n.d.)

3.1.1 Formative games

One of the first audio games was *Touch Me* (1974), released by Atari (Arcade Museum, n.d.). This electronic rhythm game featured a series of lights that would flash with an accompanying tone. The goal of the game was to reproduce the largest sequence of sounds by pressing a corresponding sequence of buttons. After each sequence, an additional random sound would be added at the end of a new sequence. In 1978, Atari released a portable version of *Touch Me*, played on a handheld device that became the inspiration for the popular game *Simon*, released in 1978 (Edwards, 2006). These games were not specifically designed for people who are blind but, because of their design, they

[33] There are over 190,000 registered users as at 18 April 2020.
[34] Game list accessed on 18 April 2020.

were accessible to both sighted and non-sighted users. In 1996, another sound-based, handheld playful device, *Bop It* (Hasbro), appeared on the market (Virtue, 2016). The interaction pattern was designed with an emphasis on audio information. The device featured a button, lever and handle. The player was challenged to listen to set of commands ('Bop it', 'Twist it', or 'Pull it') and to interact with the respective parts of the electronic console. Point values were represented by various audio tones. Other related games soon followed, including *Bop It Extreme* (1998), *Bop It-Extreme 2* (2002), *Zing-It*, *Top-It* and *Loopz* (2010).

Before graphical operating systems like Windows, most home computers used text-based operating systems such as DOS (Hansen, 2013). These text-based systems were comparatively inaccessible to visually impaired players until the addition of TTS screen reading software (Taylor, 2009). For the same reason, early text-only works of interactive fiction (Damoulakis, 2008) and text-based adventure games became increasingly accessible to visually impaired users. Multi User Dungeons (MUDs) and Single User Dungeons (SUDs) (Kelly & Rheingold, 1993) developed at the end of the 1970s and early 1980s were easily accessible to visually impaired players because of their non-graphical design. Only when RPGs and adventure games became heavily reliant on an image layer did the gap between visual and non-visual players widen exponentially.

One of the first commercial story-driven audio games appears to have been the audio adventure game *Real Sound – Kaze No Regret* (released by Sega in 1999) (AudioGames.net, n.d.), created for Sega Dreamcast and Sega Saturn gaming consoles. Unlike many previous electronic and video games, the mechanics of *Real Sound* were entirely dependent on sound. The creator of the game, Kenji Eno, stated that:

> I got tired of computer graphics … I had a chance to visit people who are visually disabled, and I learned that there are blind people who play action games. Of course, they're not able to have the full experience, and they're kind of trying to force themselves to be able to play, but they're making the effort. So, I thought that if you turn off the monitor, both of you are just hearing the game. So, after you finish the game, you can have an equal conversation about it with a blind person. (IGDA GASIG, 2013)[35]

[35] Kenji Eno, when recalling his efforts to get Sega to publish his game, said:
> So, Sega was asking for exclusive rights to the game, and I said, 'OK, if you'll donate a thousand *Saturns* to blind people, then I'll donate a thousand games along with the *Saturns*'. And my condition was that, if

3.1.2 Sonic adaptations

A popular way of designing and developing audio games is by adapting their counterparts in the visual domain (video games). The audio gaming community portal Audiogames.net categorises audio games in a manner that resembles video game genres. These categories include:

- Adventure: *The Blind Eye* (AM Production, 2000),[36] *The Last Crusade* (Dweyer & VanLund, 2004b),[37] *Chillingham* (Bavisoft, 2004),[38] *The Nightjar* (Somethingelse, 2011),[39] *Blindside* (Epicycle, 2012),[40] *A Blind Legend* (DOWiNO, 2015),[41] *A Hero's Call* (Out of Sight Games, 2017)[42]
- Action: *Papa Sangre* (Somethinelse, 2010),[43] *Papa Sangre II* (Somethingelse, 2013),[44] *Nebula* (Grey Company, 20014),[45] *Audio Defence: Zombie Arena* (Somethingelse, 2014)[46]
- Simulation: *Lonewolf* (GMA Games, 2000),[47] *Tank Commander* (GMA Games, 2003)[48]
- First-person shooter (FPS): *The Shades of Doom* (GMA Games, 2000), *AudioQuake* (Matthew Atkinson & Sabahattin Gucukoglu, 2005)[49]
- Racing: *KM2000* (Code Factory, 2000);[50] *Drive* (Tol, Huiberts & Verweij, 2002);[51] *Top Speed 1*, *2* and *3* (Playing in the Dark, 2004, 2006, 2011)[52]

> Sega would go for this idea, I would make that game Sega exclusive. So, that's how this happened. It's been several years now, and of course the contract probably isn't valid anymore, but the reason that I haven't done anything with this game is that I made this promise with Sega back in the day, and it's exclusive because of those conditions. (IGDA, 2013)

[36] https://audiogames.net/db.php?action=view&id=theblindeye.
[37] http://www.cs.unc.edu/Research/assist/et/projects/RPG/TheLastCrusade.htm.
[38] https://audiogames.net/db.php?action=view&id=chillingham.
[39] https://audiogames.net/db.php?action=view&id=The%20nightjar.
[40] http://www.blindsidegame.com/.
[41] http://www.ablindlegend.com/en/home-2/.
[42] http://outofsightgames.com/a-heros-call/.
[43] https://audiogames.net/db.php?action=view&id=papasangre.
[44] https://archive.org/details/PapaSangre.
[45] https://apps.apple.com/br/app/nebula/id874292053.
[46] https://audiogames.net/db.php?action=view&id=Audio%20defense,%20zombie%20arena.
[47] https://audiogames.net/db.php?action=view&id=lonewolf.
[48] https://audiogames.net/db.php?action=view&id=gmatankcommander.
[49] https://audiogames.net/db.php?action=view&id=audioquake.
[50] https://audiogames.net/db.php?action=view&id=km2000.
[51] https://www.audiogames.net/drive/.
[52] http://www.playinginthedark.net/index_e.php.

- Strategy: *Battleship Sv* (Games For The Blind, 2000),[53] *SoundRTS* (SoundMud, 2007),[54] *BG Chess Challenge* (Spoonbill Software, 2008),[55] *Time of Conflict* (GMA Games, 2010),[56] *Knight Commander* (Woodside Aps, 2018)[57]
- Rhythm: *AudiOdyssey* (Glinert & Wyse, 2007), *Finger Dance* (Miller et al., 2007), *Aurifi* (Punk Pie, 2010)[58]
- Arcade games: *Metris* (Inspired Code, 2001),[59] *Minesweeper* (Tyflos Accessible Software, 2010),[60] *Blindfold Hopper* (Blindfold Games, 2015),[61] *Audio Game Hub* (Sonnar Interactive Ltd, 2016).[62]

3.1.3 Hybrid games

There are also a small number of 'hybrid' games that are accessible to both sighted and non-sighted users. *The Blind Eye* (2000), *Terraformers* (Westin, 2004)[63] and *The Curb* (SoundSupport, 2005)[64] were the first games to focus heavily on audio-visual spatial exploration by leveraging binaural audio technology (Møller, 1992; Tsakostas et al., 2007; Walton, 2017) to create 3D auditory spatial environments. Such a combination gave visually impaired and sighted gamers access to the same information. More recent examples of hybrid[65] games are *Lost and Hound* (Fairbanks, 2017)[66] and *Blind VR* (Tiny Bull Studios, 2018).[67] *Blind VR* is one of the first hybrid games available on virtual reality headsets.

3.1.4 Video game modifications and accessible games

Sometimes video games are modified by gamers themselves such that they become accessible to visually impaired users. For example, *AudioQuake* (Atkinson et al., 2006) is a modification of the popular FPS game *Quake* (id Software, 1996).

[53] https://audiogames.net/db.php?action=view&id=Accessible%20Battleship.
[54] http://jlpo.free.fr/soundrts/.
[55] http://www.omninet.net.au/~irhumph/bgchess.htm.
[56] http://www.gmagames.com/toc.shtml.
[57] https://www.woodsideapps.co.uk/.
[58] https://www.pocketgamer.com/games/013576/aurifi/.
[59] http://inspiredcode.net/Metris.htm.
[60] https://www.tyflosaccessiblesoftware.com/projects.php.
[61] https://apps.apple.com/us/app/blindfold-hopper/id977279164.
[62] http://audiogamehub.com.
[63] http://terraformers.nu/#content.
[64] https://audiogames.net/db.php?action=view&id=curbgame.
[65] 'Hybrid' refers to an audio game that contains a visual interface.
[66] Available as an early access version and with a planned release date in 2020.
[67] https://fellowtraveller.games/games/blind/.

There are mainstream games that, because of musical and sound cues, are accessible to blind players. Significant examples include the *Mortal Kombat* series (1992–2019) and *Skullgirls* (2012) (Grey, 2014; Welch, 2019). Through learning the audio cues for each move, vision-impaired players have been able to master them. Other examples include games like *Super Mario 64* (1996), *The Legend of Zelda: Ocarina of Time* (Nintendo, 1998), *Rock Band 2* (Harmonix, 2008), *The Last of Us* (Sony, 2013) and *Call of Duty WWII* (Activision, 2017) (Cloutier, 2017; Lumb, 2018; Musa, 2013; Webber, 2014; Yin-Poole, 2016). Often, sighted gamers try to beat the games while being blindfolded as a form of a 'speed run challenge' (Jobst, 2020; PangaeaPanga, 2015; Summoning Salt, 2019).

3.1.5 Augmented audio systems

A small number of research groups have focused studies on the design of augmented audio systems that combine real scenery with artificial audio environments (Cohen et al., 2004; Lyons et al., 2000; Paterson et al., 2010). At the Consumer Electronic Show (CES) in 2015, researchers from Intel presented a wearable device that used RealSense technology. This set-up consisted of video cameras and proximity sensors that provided haptic feedback to the user (Johnson, 2015; Serban, 2016). Combined with 3D binaural audio, the device was used as a prototype controller for the video game *Nevermind* (Flying Mollusk LLC, 2015). Another technological advancement has been the development of racing auditory display (RAD) by Brian Smith (Evarts, 2018). Given its audio-based interface, RAD is easy to integrate into other video games and enables visually impaired users to play video games with the same speed and dexterity as sighted players.

3.1.6 Interactive audiobooks

Interactive audiobooks combine the potential of linear and non-linear narratives (e.g., books, audiobooks, radio plays, game books and branching-plot novels) with the interactive elements of computer games (Huber et al., 2007; Röber et al., 2006). The first interactive audiobook, *Raumzeit*, was released in Germany in October 2010 by Audiogent[68] (iOS platform, German language) (Chip.de, 2010). *Raumzeit* was an interactive science fiction audio story that incorporated multiple voices, sound effects and music. Interactive potentials included choosing dialogues, using objects and mini games.

[68] Audiogent released more titles in the German language in subsequent years, and these were well received by customers, despite the company announcing its closure in 2014.

The game had a visual interface and used a touch screen and accelerometer as input devices (tilting) in the mini games. Although the game was not designed for visually impaired players, it was accessible enough to play by non-sighted players. At the time it was released, a team at Polish Telecom was working on a separate interactive audiobook called *1812: Heart of Winter*[69] (Beksa et al., 2011). This fantasy interactive audio story featured 36 actors, 3D binaural sound effects and music. The game incorporated basic RPG elements such as quests, items, weapons and special powers. Other interactive audiobooks include *Codename Cygnus*[70] (Earplay LLC, 2013) and *Multi Path Audio Books* (Dave Levy, 2015).[71]

3.1.7 Audio games: current status

Audio games originated as entertainment tailored for the visually impaired and were developed mostly by small dedicated companies, hobby game designers, amateurs, game accessibility researchers and sometimes blind gamers themselves (Friberg & Gärdenfors, 2004; Nesteriuk, 2018; Rovithis, 2012; Urbanek & Güldenpfennig, 2019a). Many of these developers abandoned audio game development due to insufficient income generated from sales (e.g., BSC Games, GMA Games, Code Factory, Something Else and Klango).

In 2013 and 2014, the status of audio games began to change, with an increasing interest discernible among sound artists, researchers and game developers (Barlet & Spohn, 2012; Beeston et al., 2018b; Moss, 2014). Thanks to the popularisation of touchscreen portable devices (smartphones and tablets) and game development engines (Unity 3D, GameMaker and Unreal), increase of computing power, availability of accessible operating systems and ubiquity of mobile game platforms (such as App Store and Google Play Store), it has become easier to create and publish advanced audio games. In addition, because of the proliferation of the independent scene (indie games), crowdfunding[72] platforms (such as Kickstarter and Indiegogo) (Juul, 2019; Moritz & Block, 2016; Planells, 2015) and growing awareness of blind gamers' needs, audio games currently appear to be attracting higher levels of creative and technical exploration. There are an increasing number of

[69] Despite being well received by customers in Poland, as previously discussed the project was suspended by Polish Telecom in 2012.
[70] http://www.codenamecygnus.com/.
[71] https://apps.apple.com/us/app/multi-path-audio-books/id939328269.
[72] Crowdfunding is the practice of funding a project or venture by raising small amounts of money from a large number of people, typically via the Internet (Merriam-Webster, n.d.).

audio game projects supported through crowdfunding platforms. Significant among these are *Blindside* (2011),[73] *Blind Legend* (2014),[74] *Grail to the Thief* (2015), *Three Monkeys* (2015),[75] *Audio Game Hub* (2016),[76] *A Hero's Call* (2017)[77] and *Pitch Black* (2020).[78] Audio games have also become attractive to gamers outside of the visually impaired community (Parker, 2013; Tiny Bull Studios, 2018).

3.1.8 The influence of smart speaker technology

There is potential for the audio game industry to change because of the smart speaker revolution that began in 2014 when Amazon introduced the Alexa voice assistant and Echo smart speaker (followed by Microsoft's Cortana and Google Assistant) (Lopatovska et al., 2018; Paul, 2019). Voice assistants are intelligent personal assistants (IPA) that respond to voice commands. Thanks to a voice-controlled interface, they are fully accessible to people who are blind or visually impaired. Just like mobile devices and computers, smart speakers provide access to content through voice applications (called 'Skills' on Alexa and 'Actions' on Google Home). A rapid growth in user base and available voice applications has been observed since 2016 (reaching 100,000 Alexa Skills and 146 million smart speaker units sold in 2019)[79] (Kinsela, 2019; Wiggers, 2020). Some of the most popular voice games influenced by the smart speaker revolution include *Skyrim* (Bethesda Game Studios, 2018),[80] *The Magic Door* (The Magic Door, 2016),[81] *Escape the Room* (Stoked Skills, 2018),[82] *Jeopardy!* (Sony Pictures, 2016)[83] and *Earplay* (Earplay, 2016).[84]

3.2 Accessible game design guidelines

According to Bateman (2009), there are three types of visual disability: blindness, low vision and colour blindness. Bateman discusses disability types and gamers' demographics and proposes solutions for making video games more accessible. Araújo

[73] https://www.kickstarter.com/projects/600219258/blindside-the-audio-adventure-video-game.
[74] https://www.ulule.com/a-blind-legend/.
[75] https://www.kickstarter.com/projects/1950090942/three-monkeys-part-1-into-the-abyss.
[76] https://www.kickstarter.com/projects/191576632/audio-game-hub-keep-your-ears-wide-open.
[77] https://www.kickstarter.com/projects/1112411595/a-heros-call-an-accessible-fantasy-rpg.
[78] https://www.kickstarter.com/projects/pitchblackgame/pitch-black-the-aaa-audio-game.
[79] Previous years' sales were 5,000 Alexa Skills in 2016, 10,000 in 2017 and 50,000 in 2018.
[80] https://www.amazon.com/Bethesda-Game-Studios-Special-Edition/dp/B07D6STSX8.
[81] https://www.amazon.com/The-Magic-Door-LLC/dp/B01BMUU6JQ.
[82] https://www.amazon.com/The-Magic-Door-LLC/dp/B01BMUU6JQ.
[83] https://www.amazon.com/Sony-Pictures-Television-Jeopardy/dp/B019G0M2WS.
[84] https://www.amazon.com/Earplay/dp/B01K8V6NSI.

et al. (2017), Rutter et al. (2006) and Yuan et al. (2011) note that accessibility features in digital games are often limited to changes in screen resolution, increasing the size or contrast of game elements, volume adjustments, changes to subtitle font size and colour, and remapping of game controllers and compatibility with the screen reader software. Given these considerations, a number of independent parties (researchers, gaming communities, companies and non-for-profit organisations) have created guidelines for working with such gamers.

The AbleGamers Foundation has published a guide for game accessibility for diverse disabilities.[85] By consulting with disabled gamers, reviewing products and connecting with developers, they advocate for the disabled gaming community and reinforce the importance of accessibility. Their guide explains important accessibility options that should be considered when designing a video game and what each means to the end user (Barlet & Spohn, 2012).

The Game Accessibility Special Interest Group from the International Game Developers Association (IGDA GASIG) has published an online set of guidelines for accessible game development[86] (IGDA GASIG, n.d.-c). This list is primarily concerned with interface issues and game mechanics. The IGDA GASIG has also collected best practice guidelines, videos, articles, academic papers and tools they consider may be useful for game developers and researchers[87] (IGDA GASIG, n.d.-b).

Another useful set of online guidelines has resulted from a collaboration between a group of game studios, specialists and academics (Game Accessibility Guidelines, n.d.). This list is divided into disability types and implementation difficulty levels. The guidelines are clearly described and contain examples of best implemented practice in existing games.

Bannick (n.d.) has also proposed a list of guidelines for building blind-accessible computer games[88] that addresses compatibility with screen reader software like *Jaws* (Freedom Scientific, 1993), *Windows Eyes* (GW Micro, 1995) and *Supernova* (Dolphin Computer Access, n.d.) (Accessibility Chatter, 2012) for the PC Windows platform. Some of the recommendations might apply to console and smartphone games.

[85] https://www.includification.com.
[86] http://igda-gasig.org/get-involved/sig-initiatives/resources-for-game-developers/sig-guidelines/.
[87] https://igda-gasig.org/how/for-developers-researchers/.
[88] http://www.blindcomputergames.com/guidelines/guidelines.html.

The W3C group has also published comprehensive Web Content Accessibility Guidelines (WCAG 2.0)[89] for designing and developing accessible websites. Some of these guidelines have potential application to audio game development (W3C, 2008).
For mobile application developers, Apple[90] (n.d.) and Google[91] (Google LLC, n.d.-c), have provided a comprehensive set of instructions on how to create accessible applications. While these documents are not geared specifically towards games, game developers may find them a reliable source of information when planning screen reader support (VoiceOver[92] [Apple Inc., n.d.-b] or TalkBack[93] [Google LLC, n.d.-b]).

Supporting such guidelines are a number of legal initiatives for making games more accessible. Indicative of these is the United States (US) *Twenty-First Century Communications and Video Accessibility Act of 2010* (CVAA). This piece of general purpose legislation requires accessibility of all communications services (specifically voice chat, text chat and video chat), including those in game software, gameplay and distribution networks, and consoles (IGDA GASIG, n.d.-a).

The aforementioned guidelines were helpful in developing this project because ongoing attention to issues of accessibility remains an important part of reaching higher levels of equity in the field. This being said, effective audio game accessibility does not ensure that a game will be fun to play or commercially successful. As an Indie Designer/Developer, one balances insights into accessibility with the pursuit of novel ways that artefacts might elevate joy, challenge and excitement in a game experience.

3.3 Academic discourses surrounding audio game design and development

Research into audio games and audio game design has evolved substantially in the last two decades. Because of the interdisciplinarity of the field, the range of questions generated and methods employed in research is diverse.

[89] https://www.w3.org/TR/WCAG20/.
[90] https://developer.apple.com/accessibility/.
[91] https://developer.android.com/guide/topics/ui/accessibility/apps.
[92] https://www.apple.com/nz/accessibility/iphone/vision/.
[93] https://support.google.com/accessibility/android/answer/6283677.

A useful review by Nesteriuk (2018) identified 65 articles, book chapters, conferences and proceeding papers related to audio games published between 1999[94] and 2016. Nesteriuk also identified the most cited keywords in these publications which he lists as 'accessibility, video games, audio games, visual impairment and blindness' among others (p. 8). In an attempt to summarise the diversity of topics related to computer-based audio gaming, Urbanek and Güldenpfennig (2019) conducted a literature review with a focus on audio game design. They proposed a framework that grouped research strands into four themes:

- crafting audio gaming experience
- user participation and evaluation
- technological progress
- input and output techniques.

In a similar vein, this review focuses on three themes that relate to or contextualise the *Audio Game Hub* project:

- inclusive and accessible design
- audio games gameplay mechanics
- audio game engines and development tools.

3.3.2 Inclusive and accessible design

While visual design principles focus on the significance of shape, colour and size, an auditory interface design is distinguished by its use of sound qualities like pitch, volume, and placement in 3D space. Friberg and Gärdenfors (2004) note the necessity, when designing audio games, of maintaining high aesthetic standards while retaining functionality. Collins (2013) and Hermann (2011) suggest that this equilibrium may be enhanced by not overloading an *auditory display* with too much information.

One of the first audio game design guidelines was compiled by Targett and Fernström (2003) who presented a number of design ideas implemented in two audio games they created for therapeutic training for memory and concentration. They proposed that

[94] Early discourse related to audio games can be traced back to Lumbreras and Sánchez (1999) who introduced the idea of interactive audio hyperstories for blind children. The system was implemented in their prototype audio game *AudioDoom*. Hyperstory is an interactive story with a non-linear plot where interaction with objects or characters can trigger a change in the story.

'earcons'[95] and 'auditory icons'[96] can be used together to 'sonify' different types of data within a single interface (audio).

After examining various audio game prototypes, Friberg and Gärdenfors (2004) proposed a categorisation system for sounds that they suggested might be useful when designing and developing new games. They divided audio interface sounds into six categories: 'avatar, object, character, ornamental, instructions and user interface' (p. 151). They argued that in an effective game, a player should be able to distinguish whether perceived sounds are being triggered by their activity or autonomously by the game.

Röber and Masuch (2005a, 2005b) analysed audio-only games to derive a set of basic rules that might be useful for audio game design and development. They distinguished three fundamental elements used in the creation of sonic environments: speech, music and natural and artificial sounds. Each of these auditory forms is suited to expressing specific kinds of information. Speech, they argued, is normally employed as a narrative element, whereas music is normally used to enrich the sound field and influence a listener or change their mood. Conversely, they suggested that natural and artificial sounds are essentially audio signals that depict a physical object or process. Their concepts were evaluated and developed into four self-designed audio games. They also emphasised the potential of mobile devices because they allow gamers to play practically anywhere.

Liljedahl et al. (2007) investigated how a radical shift from eye to ear can influence the experience of playing a simple arcade style computer game. They tested the audio game prototype *Beowulf* with sighted users and highlighted principles of sound design and the scary shadow syndrome.[97] The results showed that players will have richer and more immersive game experience if they are emotionally invested in the experience.

[95] Introduced by Sumikawa (1985), 'earcons' are audio cues used in computer user interfaces to provide information and feedback about objects, operations or interactions. For example, while scrolling up and down a page, the user can gain information about their place in the document via sound pitch (a high pitch for the top and a low pitch for the bottom).
[96] Introduced by Gaver (1986), an auditory icon uses natural sound recordings to represent objects and actions in the interface. For example, when a file is dragged across the screen to the recycle bin, the noise of paper scrunching can be heard.
[97] 'Scary Shadow syndrome' comes from an observation that horror films are more effective without large production budgets and overwhelming visual effects. The authors suggested that 'less is more' and that not showing everything and instead allowing players their own interpretation will add value and intensity to their experience (Liljedahl et al., 2007).

Papworth (2010) reviewed existing knowledge in game design for sound-based games and described the background and development process of *iSpooks* (an audio-based adventure game for the iPhone). He discussed the manner in which audio provides unique opportunities in game design and emphasised it as a principle mechanism for driving the gameplay.

Yuan et al. (2011) presented the current state of the field of video game accessibility. Their research involved surveying a large sample of accessible games for different types of impairments, so they could harvest a selection of high- and low-level strategies that might be useful for game developers. Their results showed that applying accessibility features in a game can significantly alter the gameplay. They also emphasised that designers/developers must be wary to not create games that are functional but not fun to play.

In a literature review on audio game design and implementation, Garcia and de Almeida Neris (2013) proposed a set of audio game design guidelines. Their 50 design recommendations were based on case studies and their own observations. The authors provided advice on how to present audio to achieve better accessibility in audio games. They also proposed that audio games should be designed inclusively, not just for people with visual impairments.

Rovithis et al. (2014) discussed existing approaches in audio game design and grouped their design principles into three categories: 'organizing the sonic content', 'navigation and feedback sounds' and 'narrative content'. The researchers proposed an approach for designing educational audio games and presented a case study that outlined the development of two games. Significantly, they argued that video games should not serve as templates for audio game design; instead, audio games (being paradigmatically different) should be designed from scratch.

In 2015, Lazar et al. published an overview of current laws, policies, regulations, technical standards, best practices and suggestions for implementing accessibility features. To this they added a discussion of techniques for compliance monitoring. They presented a history of accessible computing and provided real-life examples of laws and regulation implementations in addition to lawsuits related to accessibility issues.

More recently, two research projects have concerned themselves with proposals for effective audio game design. Araújo et al. (2017) suggested 10 recommendations for the design of mobile audio games. The researchers developed an evaluation instrument based on the Web Content Accessibility Guidelines (WCAG) 2.0 classification and organisation (W3C, 2008). This instrument was used to evaluate 10 mobile games labelled as accessible. Usefully, the authors discussed the challenges faced by sighted game designers/developers, who are often unfamiliar with the needs of visually impaired players.

Following Araújo et al.'s (2017) recommendations, Urbanek et al. (2018) formulated 11 'anti-rules' for audio game design based on an analysis of 157 audio game prototypes. These rules were formatted as a list of what designers should not do when designing and developing an audio game. The researchers proposed three lenses for audio game design: signal, mapping and game. Proposing that their anti-rules might be expanded, they suggested that their collation might help designers/developers avoid common design mistakes that can ruin players' experience.

Beeston et al. (2018a) conducted a demographic survey of 154 players with disabilities and found that they play mainstream digital games using a variety of assistive technologies (e.g., eye tracking, screen reader and alternative controllers). Their research showed that players use accessibility options such as key remapping and subtitles. It also revealed that players with disabilities play for similar reasons as non-disabled players (i.e., for fun, relaxation, challenge and a sense of community). In terms of game design, the researchers suggest that minimal additions and modifications to games (such as key remapping, auditory alerts or alternative controllers support) can accommodate a substantial audience of disabled players.

Urbanek and Güldenpfennig (2019b) conducted 14 interviews with seven experienced audio game players and designers. The authors attempted to capture the contextualised experiences of audio game enthusiasts to advance audio game design. The results of their inquiry showed that audio games can enrich players' lives 'through creativity, play, and social exchange' (p. 253). These outcomes were enhanced by features like aesthetics, enjoyability, accessibility and the availability of audio games.

In relation to the development of the games in this thesis, my position is closely aligned with Yuan et al. (2011) and Urbanek and Güldenpfennig (2019b) who emphasise a

relationship between designer/developer's insight into accessibility experience and the pursuit of an exciting positive game experience. I also concur with Garcia and de Almeida Neris (2013) and Nesteriuk (2018) who believe that games (mainstream and indie) should be designed inclusively for both sighted and non-sighted players. Of direct support in the project was research into the nature of sonic design and functioning (Collins, 2013; Friberg & Gärdenfors, 2004; Hermann, 2011; Liljedahl et al., 2007).

While compiled guidelines (Röber & Masuch, 2005a, 2005b; Garcia & de Almeida Neris, 2013; Araújo et al., 2017; Urbanek et al., 2018) were useful in providing overviews of experience and advice, in the *Audio Game Hub* research project, many of their observations surfaced naturally through direct feedback from gamers after our prototypes were posted online.

3.3.2 Audio games, gameplay mechanics and user interfaces

Traditionally, audio games were designed to be played on a stationary computer (Lumbreras & Sánchez, 1999; Targett & Fernström, 2003). However, since the late 2000s, audio game development has tended to move away from the computer and engage players in more agile ways. This correlates with the emergence and growth of portable computers, mobile phones, smartphones and tablets (Araújo et al., 2017; Röber & Masuch, 2005b; Roden et al., 2007).

Input

Since the emergence of the first audio game, *Touch Me* in 1974 (Arcade Museum, n.d.), different types of user interfaces for input have been used. The main input devices for audio games include the keyboard (Drewes et al., 2000; Gaudy et al., 2009; Liljedahl et al., 2007; Westin, 2004), game controllers (Friberg & Gärdenfors, 2004; Lumbreras & Sánchez, 1999; Mccrindle & Symons, 2000; Mendels & Frens, 2008) or touch screens (Giannakopoulos et al., 2018; Milne et al., 2014; Papworth, 2010). Although a mouse is not commonly used by blind gamers, some researchers have employed it as a input device (Allain et al., 2015; Bălan et al., 2014; Parker, 2013).

Some researchers have also utilised hand gestures to interact with a game. Gestures can be performed using hands and captured by hand tracking devices such as Leap Motion[98] (Wu & Rank, 2015). Other teams have employed dedicated controllers such as Kinnect (Morelli et al., 2010; Morelli & Folmer, 2011), haptic gloves (Yuan & Folmer, 2008) or smartphones and tablets (Rovithis et al., 2019).

Researchers have also explored the design and development of custom controllers for use in exergames (exercise games). Lee et al. (2013) created a motion-based 'swimming' game that used a wearable sensor accelerometer to provide feedback about a player's location in the water. In the exergame *Sonic-Badminton* (Kim et al., 2016), designers modified a typical badminton racket and shuttlecock with wireless sensors so the device provides players with information about position and distance.

Research teams have also experimented with a player's physical movement and position by creating prototypes of 'real walking' or location-based audio games. These games use the Global Positioning System (GPS) (Chatzidimitris et al., 2016; Paterson et al., 2010; Velleman et al., 2004) or indoor positioning systems (virtual reality) (Allain et al., 2015; Andrade et al., 2019; Moustakas et al., 2009; Podkosova et al., 2016).

The recent growth of personal voice assistants (Paul, 2019) is opening the possibility of new kinds of games (Cicció & Quesada, 2018). Voice assistants do not require a visual interface and can be operated by giving voice commands only. Therefore, any 'voice' application (including games) is potentially accessible to people with vision impairment.

Output

Audio games are usually played using headphones rather than speakers (Lumbreras & Sánchez, 1999; Röber & Masuch, 2005b). Headphones allow designers to utilise stereo panorama and 3D sound spatialisation (Lumbreras & Sánchez, 1999; Tsakostas et al., 2007). Researchers have used headtracking devices (Röber & Masuch, 2004) or augmented and virtual reality headsets to utilise the advantages of 3D binaural audio (Tsakostas et al., 2007) and to enhance the auditive perception of gamers (Afonso et al., 2005; Andrade et al., 2019; Moustakas et al., 2009; Rovithis et al., 2019).

[98] https://developer.leapmotion.com/.

In addition to audio feedback, researchers have also incorporated haptic stimuli. The designers of *Audio Space Invaders* (Mccrindle & Symons, 2000) used a joystick controller that provided haptic feedback through a vibration mechanism. Another team (Yuan & Folmer, 2008) created a set of gloves that offered haptic feedback (as an replacement to visual cues) in the rhythm game *Guitar Hero.* This modification made the game accessible to blind gamers. Another team of researchers presented a prototype game using a set of proximity sensors and a wearable device that provided haptic feedback to the player when they approached a physical object (Johnson, 2015; Serban, 2016).

In addition to these innovations, at the Consumer Electronic Show (CES) in 2015, researchers from Intel presented a wearable device that employed RealSense technology. This set-up consisted of video cameras and proximity sensors that provided haptic feedback to the user.

3.3.2 Audio game engines and development tools

Often researchers and designer/developers create software tools that support the creation of audio game prototypes. These tools include game engines (Archambault, 2004; Drossos et al., 2015; Stadler & Hlavacs, 2018) that are often accompanied by game or map/level editors (Balan et al., 2015; Dweyer & VanLund, 2004a; Matsuo et al., 2016; Urbanek et al., 2019). There have also been attempts to create accessible programming environments that enable visually impaired and blind developers to create their own audio games (Kane et al., 2018; Klango, 2006). Such tools facilitate the creation of multiple games in a shorter timeframe and the establishment of new genres (provided the engine is shared with the design community) (Archambault, 2004; Röber & Masuch, 2005a). For example, this happened with Twine[99] for interactive stories.

Archambault (2004) developed a game engine and editor that was used to create games that could be played on personal computers using a keyboard, in addition to tactile devices like Braille keyboards, boards and displays. The research was focused on game interactions and the potential of such games in educational and therapeutic environments.

[99] https://twinery.org/.

In the same year, Dweyer and VanLund (2004a) developed a game engine and map editor that allowed for the creation of audio-only RPGs. Together with the tools, they released the game *The Last Crusade*.[100] This game had no visual interface and was one of the first attempts to create a rich audio adventure story. The creators also provided a source code that allowed for game engine and map editor modifications.

In 2006, Polish developers released a programming environment for developing and running interactive audio games[101] and applications (Klango, 2006). This was the first attempt to make audio game development accessible to blind developers. The Klango environment consisted of two modules. The Player (also called the 'lounge') allowed users to select an application (game) to run. They could also change global settings such as volume levels or key mapping.[102] The Engine and a compiler at the same time allowed one to create Klango applications. This tool was based on the programming language *Lua*[103] and worked with any external text processor. Klango enabled programmers to create advanced audio applications (including games) easily. Some of the first Polish audio games created in this environment include *Cosmic Darts*[104] (2006), *Haunted Factory*[105] (2006) and *Pirate Memory*[106] (2006). The Klango project was abandoned in 2009.

Röber et al. (2006) introduced the concept of interactive audiobooks, which are a combination of non-linear narratives and interactive elements from computer games. The authors created an audio story engine and an authoring tool together with set of guidelines and best practices on how to create interactive audiobooks. This work was later used in German start-up *Audiogent*.[107] A year later, Roden et al. (2007) expanded this idea and created a framework for authoring interactive narrative-based audio-only games set in 3D virtual environments. Novel features of their solution were 3D audio support, real-time gameplay and multiplayer support. This framework was used to create the prototype audio game *Dragon's Roar*.

---

[100] *The Last Crusade* was one of the first audio-only games I had ever played, and I used the included map editor to create first prototypes of audio games tested at Polish Telecom. The game was also an inspiration for other games I developed including the interactive audiobook *1812: Heart of Winter* and *Labyrinth* (which was part of the Audio Game Hub).
[101] The Klango website is no longer available but games can be downloaded from online repositories of audio game player (e.g., http://superfon.myftp.org:9080/gry%20dla%20niewidomych/nowe%20gry%20klango/).
[102] *Klango Player* was an inspiration for the *Audio Game Hub* concept of a composite application that contained multiple games.
[103] http://www.lua.org/.
[104] *Cosmic Darts* was an inspiration for the *Archery* game.
[105] *Haunted Factory* was an inspiration for the *Blocks* game.
[106] *Pirate Memory* was an inspiration for the *Memory* game.
[107] https://heureka-conference.com/audiogent-interactive-apps/.

Since the mid-2010s, researchers and designers/developers have begun using commercially available game engines such us Unity 3D.[108] These have shortened development time and allow publishing on multiple devices and platforms (e.g., iOS, Android and PC) by writing one code (Unity Technologies, 2017). Examples of audio-only games created in Unity Engine are *FREEQ* (Psychic Bunny, 2013) (Hughes, 2013), *Blindside* (Epicycle, 2012) and *Tic-Tac-Toe* (Drossos et al., 2015). Thanks to Unity Engine plugins (like the UI Accessibility Plugin[109] and Blind Accessibility[110]), games created in this engine support native screen readers who are using mobile devices (Hamilton, 2017).

In 2018, Kane et al. developed an accessible programming environment for blind programmers who struggle with navigating complex code documents while using screen readers. *Bonk* enables novice developers to create, share, play and modify accessible audio games. This JavaScript[111] programming language-based tool enables one to create interactive audio stories, text adventure and simple action audio games. Games developed using *Bonk* can be played on any modern desktop or mobile web browser.

In the same year, another team of researchers (Stadler & Hlavacs, 2018) developed a game engine that runs on smartphones and was explicitly released for blind and visually impaired designers/developers, enabling them to create and share their own games. Designers using the engine are able to create game levels by choosing from a variety of interactions including minigames, quizzes, fights and interacting with objects. The application was created in the Unity 3D engine and is available on iOS and Android platforms.

Based on their previous work (Urbanek et al., 2017, 2018), Urbanek et al. (2019) have recently released a browser-based audio game editor developed based on feedback from experienced audio gamers. It was inspired by other game engines (e.g., Unity 3D). The key feature of the editor is its ease of use because it allows designers to drag and drop game elements on a 2D representation of the game area. This tool also allows instant audio rendering and play testing. Researchers, in anticipation of building an audio game designer/developer community, have released the editor code under an open source

[108] The *Audio Game Hub* and *Blind Cricket* were created using the Unity 3D engine.
[109] https://assetstore.unity.com/packages/tools/gui/ui-accessibility-plugin-uap-87935#description.
[110] https://assetstore.unity.com/packages/tools/integration/the-blind-accessibility-for-unity-game-99134.
[111] https://developer.mozilla.org/en-US/docs/Web/JavaScript.

licence.[112] This decision supports sustainability and allows for modification and re-use of the code.

In recent years, an increase in available tools supporting audio game development has become discernible, not only in academic communities (Kane et al., 2018; Stadler & Hlavacs, 2018; Urbanek et al., 2019) but also in commercial environments (Hamilton, 2017). These are opening up more possibilities and opportunities for Indie Designers/Developers interested in developing audio games for people with vision impairment.

3.4 The Indie Designer/Developer

In closing this review of contextual knowledge, it is useful to consider emerging literature relating to the concept of the Indie Designer/Developer. According to Urban Dictionary (n.d.), the term 'indie game' is an informal truncation of 'independent game' and these terms are often used interchangeably.[113] An authoritative definition appears to be somewhat ambiguous and there are numerous discussions relating to the term. The concept of the Indie Designer/Developer has evolved over time and has been characterised by diverse perspectives (Perez, 2019).

Independent games have been compared to a range of other art forms including arts, entertainment and media, and independent cinema and music (Juul, 2014; Lipkin, 2013; Michael, 2003; Zimmerman, 2002). Both Azerrad (2012) and Sharp (2013) have linked the term 'Indie style' to punk music and its opposition to mainstream production and distribution processes. The word 'Indie' has also been associated with the movement's lack of polish, small budgets, community roles, authenticity and elevation of personal/independent creation. These features have also connected independent game

[112] 'Open source' means that software can be used, modified and shared without any restrictions (Opensource.org, n.d.).
[113] According to Dictionary.com, the word 'independent' has its origins in the beginning of seventeenth century and refers to person or a thing that is not influenced or controlled by others in matters of opinion or conduct. The dictionary suggests 'independent' may relate to 'someone who is thinking or acting for oneself; someone who is not subject to another's authority or jurisdiction, who is autonomous or free; someone who is not influenced or controlled by actions of others' (Dictionary.com, n.d.-a). The same dictionary suggests that the word 'indie' 'has its origins in the 1940s and refers to an independently or privately owned business, work or professional practice, especially in the creative industries such as music, film and gaming'. 'Indie' can also be defined as a genre describing an independent nature of its production (Dictionary.com, n.d.-b).

development to ideals of the Maker movement (Dougherty, 2012; Hatch, 2013) and the DIY (Do-It-Yourself) movement (Spencer, 2005).

In 2016, Latorre attempted to define indie game development by differentiating it from the mainstream production and distribution dynamics of the video game industry. Lipkin (2013) notes that mainstream commercial video games are published by large companies/corporations that are usually associated with a capitalist paradigm where there is an emphasis on 'profit and popularity over creativity and artistry' (p. 9). Similarly, AAA titles[114] are often developed by large teams with budgets that can reach millions of dollars (Schultz, 2018).

Michael (2003) has described an Indie Designer/Developer as an 'individual or company who provides their own funding and do not rely on money from a game publisher to create their game' (p. 4). He suggests that Indie developers 'walk their own paths and follow their own visions' (p. 4). Often, he observes, they are rebels, contrarians and independent from the mainstream. Michael suggests that an Indie Designer/Developer possesses three key traits: passion, pace and perseverance. He argues that passion provides the initial spark. He suggests that it is often the dream of making games or the need to create a unique game of one's own that ignites this drive. Pace and perseverance are qualities that he suggests enable the game development to be completed, even though the Indie Designer/Developer may be working without an established roadmap. Michael compares the pacing of time and energy management in game development to a marathon that challenges both members and resources. He discusses the relationship between perseverance and leadership, specifically the ability of an Indie Designer/Developer to stand against the odds, overcoming obstacles and demonstrate commitment and consistent willpower in the pursuit of goals.

Garda and Grabarczyk (2016) suggest that an independent designer/developer may embody specific kinds of independence that include financial, creative and publishing. They argue that the term 'indie game' should be understood as a narrow notion that refers only to a set of games produced in a specific time and place after many of the practices and tendencies (e.g., new platforms for digital distribution) began to consolidate in the mid-2000s in North America.

[114] 'AAA' is an informal classification that indicates a game has been published by a large established company with a relatively large development and marketing budget.

In *Handmade Pixels*, Jesper Juul (2019) considered the claims of developers, players and game festivals that portrayed independent games as unique handcrafted objects in a globally distributed digital medium. He emphasised the significance of independent video games as cultural works that can rise above mass-market products to become cultural works created by innovators and promoted as comparatively more authentic alternatives to mainstream games. He argued that the independent games movement borrowed the term 'independent' from film and music while it was finding its own form of independent authenticity. Like Michael (2003) and Garda and Grabarczyk (2016), Juul (2019) describes features of independence in game design and development which he proposes are financial, aesthetic and cultural. He suggests that financial independence means that the game is financed by its creator or its community. This, he argues, gives the developers greater creative control to make their games more personal. Aesthetic independence implies the use of design approaches that situate independent games separately from mainstream games. Cultural independence allows independent games to carry a cultural, political, or moral premise that can enable them to be positioned closer to aims related to design for 'social good'. Juul also recognises that independent and indie games have distinct meanings in different regions (e.g., experimental and hobbyist *doujin* games in Japan).

In 2012, the documentary film *Indie Game: The Movie* (Swirsky & Pajot, 2012) presented the personal struggles of independent game developers working under difficult circumstances to become financially successful. The documentary tended to present these developers as romantic heroes – singular, talented and facing a giant industry. It depicted them as individuals who sacrifice their time, money, social life and mental and physical wellbeing to pursue dreams and artistic ideals. The film suggested that independent designers/developers are driven by a need to remain authentic and personal, and, given this position, that their games may be considered works of art. In their documentary, the four featured developers derived their passion for game development from the passion of playing video games in their childhood. The film activated focused discussion around the concept of indie (Anthropy, 2012; Juul, 2019; Latorre, 2016; Lipkin, 2013; Ruffino, 2013). One year prior to the film's release, Antrhopy (2011) had described indie developers as a small 'exclusive club, an inner circle to which most people aren't admitted'. A year after the documentary, Ruffino (2013) aligned the heroic portrayal of indie game developers with the profile of the lone entrepreneur.

Valentine (2018) and Lisefski (2019) suggest that an indie developer is often a 'generalist' who orchestrates a wide array of skills and knowledge and performs multiple tasks in a project. Both suggest that such designer/developer can be distinguished from a traditional game development 'team member' who exercises a narrow specialisation in a specific domain. Latorre (2016, p. 22) describes an indie game developer as an 'entrepreneurial hero' associated with values like meritocracy, talent, hard work, the ability to adapt to an unstable job environment, and the ability to constantly update and reinvent themselves. He also suggests that indie game developers exhibit competitive attitudes. According to Bies (2017), these entrepreneurs have the potential to redefine how video games are perceived, such that they become an art form, an entertainment medium and a business.

In recent years, there has been a significant increase in publications (Bies, 2017; Daglow & Ismail, 2018; Dreskin, 2015; Futter & Bithell, 2017; Hill-Whittall, 2015; Schreier, 2017; Schwarzl, 2014) and podcasts (Norman, n.d.; Powell, n.d.) that deal with how such designers/developers might find entrepreneurial success in the video game industry. Lipkin (2013) and Latorre (2016) argue that a crucial feature of the indie game movement (or any artistic movement) is that they change. Gough (2019) has noted that the emergence of new online distribution channels,[115] social media[116] and the rise of video games for mobile devices have resulted in a significant decline in physical sales over the past 10 years.[117] Latorre (2016) suggests that these factors have enabled indie developers to access a wider audience and market their games with lower budgets and without the need of a publisher. As far back as 2008, Irwin noted that digital self-publishing was changing the revenue-share ratios between developers and publishers. He recorded that games purchased from a retailer retained around 17% of the price for the developer. However, he predicted that in digital distribution the developer might retain up to 85%.

Another important aspect of the indie game movement is the emergence of low-cost game development tools[118] and asset stores[119] (TNW, 2016). Historically, high-end, large game engines have been expensive and available only to a select group (Juul, 2019). Currently, many engines have a free version that enable anyone with a computer to experiment with game development. Beck (2019) has noted that game engines have made development

[115] Such as Xbox Live (Microsoft), PlayStation Network (Sony), Steam (Valve Corporation), Google Play Store (Google) and App Store (Apple).
[116] Such as Facebook, Twitter, YouTube and Twitch.
[117] From 80% of total game sales in the US in 2009 to 17% in 2018 (Gough, 2019).
[118] Such as *Unity 3D Engine* (Unity Technologies), *Unreal Engine* (Epic) or *GameMaker* (YoYo Games).
[119] Such as *Unity Asset Store* (Unity Technologies), *GameDevMarket* or *Super Game Asset*.

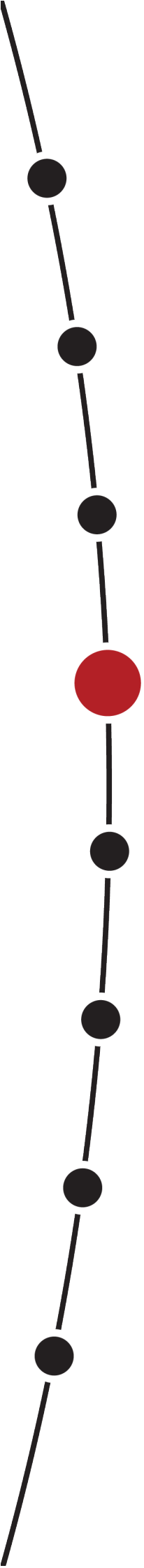
more accessible and affordable and suggests that this may be a significant factor impacting on the growth of the indie game movement growth.

A promising change in support of financial independence is the rise in popularity of crowdfunding platforms such as *Kickstarter* and *Indiegogo* (Moritz & Block, 2016; Planells, 2015; Tyni, 2017). These platforms enable independent developers to secure funding 'up front' so they can avoid releasing unfinished games to generate first revenue. This model was previously reserved for established developers and those under the patronage of major publishers (Lipkin, 2013). Edwards (2012) suggests that crowdfunding platforms empower players to influence what games will be made and enable them to support their favourite developers directly. It is this dynamic, he suggests, that creates and sustains the indie community.

However, popularity and success can open up Indie Designers/Developers to co-optation by mainstream publishers. An example of this phenomenon is *Minecraft* (Mojang, 2011), whose developer was bought up by a larger company (Microsoft). In an interview, *Minecraft* creator Marcus Persson admitted that in some respects he is 'no longer an indie' (Makuch, 2012, para. 1). He suggests that in the past indie developers were not expected to charge for their games, but now 'it's become hip to pay for indie games' (para. 6). The colonisation of indie games by mainstream companies is not a new phenomenon. Back in 2009, Martin and Deuze noted a growing interest of mainstream companies in publishing indie games, with some even establishing their own 'indie' brands. They also noted the appearance of publishers specialising in publishing indie titles.

In this thesis, I position the *Audio Game Hub* and *Blind Cricket* as outcomes produced by an Indie Designer/Developer. While I do not necessarily agree with certain idealised views of such creators (Latorre, 2016; Swirsky & Pajot, 2012), my games have been largely developed and refined independently (Michael, 2003) in the context of a rise of increased facilities for crowd funding (Moritz & Block, 2016; Planells, 2015; Tyni, 2017), low-cost game development tools (Juul, 2019) and asset stores (TNW, 2016). I see the games I have designed and developed as residing outside of mainstream production processes and funding (Garda & Grabarczyk, 2016); instead, they are crafted artefacts that are globally distributed and positioned as alternatives to mainstream games (Juul, 2019; Lipkin, 2013). As a practitioner, I function as a multidimensional 'generalist' (Lisefski, 2019; Valentine, 2018) who utilises perseverance and tenacity (Michael, 2003) and works flexibly in the face

of change (Latorre, 2016; Lipkin, 2013). My working processes integrate both independence and respect for the thinking and critique of others, so I do not align my approach with Antrhopy's (2011) exclusivity and technological and social elitism. Instead, like Bies (2017), I see my work as contributing to an enriched diversity in the way that games might be designed, developed and perceived as art forms and entertainment media. Their creation is underpinned by an independent development model that draws on user support, ongoing critique and iterative designer reflection.



Research design

In this chapter, I discuss the research design and values underpinning the development of the project.

Research may be understood as an original investigation undertaken to gain new knowledge and understanding (Bourgeois et al., 2012; Hiles, 2001). This idea is echoed the New Zealand Tertiary Education Commission's (2016) definition of 'research':

> original, independent investigation undertaken to contribute to knowledge and understanding and, in the case of some disciplines, cultural innovation or aesthetic refinement [and] in some disciplines, research may be embodied in the form of artistic works, performances or designs that lead to new or substantially improved insights. (p. 14)

There are a number of significant concepts in this definition: the idea of independent investigation, the concept of 'cultural innovation' and the development of iterative design that leads to new or improved insight.

In considering the research design underpinning the project, this chapter discusses:

- the nature of creative production in doctoral research (Scrivener, 2000)
- practice-oriented inquiry
- a heuristic framework and its relationship to an Indie Designer/Developer
- methods employed in the development and realisation of the 13 games that comprise the creative output of the inquiry.

4.1 The nature of Creative Production

This thesis inquiry may be defined as a 'Creative Production' project (Scrivener, 2000). According to Scrivener, Creative Production research is 'inventive and imaginative, and realised through artefacts' (p. 15). He argues that 'creative production, as an object of experience, is more important than any knowledge embodied in it' (p. 6). If we consider an object (artefact) as an experience, we might understand it as a journey where a bond exists between 'ways of making, seeing, saying and thinking' (p. 273). He identified six distinct norms of creative production research that separate it from research that might be defined as 'problem-solving' in its orientation. These norms are outlined in column 1 of Table 4.1, while my own thinking about such research is presented in column 2.

Table 4.1.

Norms of creative production

Scrivener's (2000) norms of creative production	My thinking on the nature of this inquiry
Artefacts are produced.	The *Audio Game Hub* consists of new artefacts (games and refined prototypes). The games are objects of value in their own right, but they may also contain knowledge that is useful in the development of other related games.
Artefacts are original, in a cultural context.	I describe my games as novel[120] because in their designed form they have not existed before. However, although they are the result of independent investigation, they draw on a certain amount of knowledge that existed prior to their development. The games are designed for a global culture of games playing. As such, there are certain assumptions within their design that relate to pre-existing knowledge about the use of computers, mobile devices and accessibility software. Games are resourced and limited by author's cultural context; I am a sighted designer/developer who was born and raised in communist Poland, I have played games since childhood, but I also live and work in a Western, Pacific country (New Zealand).
Artefacts are a response to issues, concerns and interests.	The *Audio Game Hub* games were a response to a paucity of good quality accessible games for blind and visual gamers. They were also a response to issues experienced by some of these gamers who I know personally.
Artefacts manifest issues, concerns and interests.	The *Audio Game Hub* is concerned with drawing non-sighted and sighted people together through play. It allows and encourages sighted players to try to play with no visuals (multiplying their high score). By engaging with the games, they may experience gaming from a blind gamer's perspective.
Artefacts contribute to human experience.	The games are designed to contribute directly to human experience. Appendix D provides examples of experiences that users have experienced with the *Audio Game Hub*. The four core experiences were: • 'Feeling like a real sportsman' (*Blind Cricket*) • 'Being in a real casino' (casino games) • 'The thrill of the competition' (This implies that the visually impaired users felt that they were a match for an adversary who might have been sighted) • Feelings of increasing confidence and skill.

[120] I define 'novel' as an artefact or system that is new and does not significantly resemble something formerly known or used. Although in its design a novel artefact may draw on existing knowledge, it is distinguishable from a reproduction or largely derivative work.

Scrivener's (2000) norms of creative production	My thinking on the nature of this inquiry
	The *Audio Game Hub* also enabled joint gaming experiences between sighed and non-sighted family members.[121]
Artefacts are more important than the knowledge embodied in them.	This is a complex assertion. My position is that an artefact can be a result of knowledge, but in its physical form it is not knowledge itself. A gamer or game producer with prior knowledge, might possess knowledge related to the creation of an artefact (in other words, they may appreciate technically what lies behind the surface or they might recognise innovation within a game). Therefore, to such people, the artefact may be conceived of as an 'expression of knowledge', but it is not the game itself that is knowledge; what is being recognised is the thinking behind its design. Some knowledge may not be perceivable in an artefact, but the artefact may have relied on its presence. For example, tacit knowledge used by the designer may have helped a designer to make decisions as to what to include or exclude from the design. It may also have been used in the designer's critical evaluation of iterative versions of the game. For many gamers, a 'playful' experience of the artefact may be more important than knowledge embodied in it, because they engage with the artefact in a state of flow and, therefore, are consumed by the excitement of the experience rather than the thinking behind the artefact (Csikszentmihalyi, 2008).

In addition to Scrivener's (2000) six norms, I suggest one more. I believe that in a creative production process the outcomes cannot be pre-determined. So, we might understand a

[121] For example:

> Hi, I wanted to write this email to express not only my thanks and gratitude but also my complete amazement of your Audio games hub app. I am partially sighted and my wife is fully sighted and to be able to play games with her is just fantastic. You made possible something I thought I wouldn't ever see. It's about the games yes certainly, but the experiences, the laughs and fun we can have because both sighted and visually impaired people can play these set of excellent games together. So for the fun we have had so far and the fun we will have in the future I can't thank you enough. I hope more games will be on the way, at the moment Android doesn't have allot of high quality audio games but yours is certainly one of the best. Thank you and take care. (Riz, personal communication, April 27, 2016).

Another example:

> It's Eric from the Blind iPhone on Twitter. So, I have 2 kids, one is 17 and one is 5. They are both sighted. I have RP so I am legally blind. They both love games and are very competitive. I was playing a few games on the iPad and my son, the 5 year old, came over to look. Surprisingly for an audio game, there were graphics so he could tell what was going on. I went through most of the games and found the Samurai games. I played Samurai Tournament and did well so when my daughter passed by, I challenged her. She crushed me…lol. We were laughing and my son came by. I put on the Samurai Dojo game and we put it to 4 players and took out the 4th player every time each match started. We were on the game for at least 1 hour taking turns at winning. Eventually, I was losing more than winning because my fingers are bigger and in 4 player mode, the corner tap section is small. All in all, we had a blast playing Samurai Dojo. We went through a few other games as well. My daughter loved and completed the Archery game. on her second time playing. I am pretty good at games, I still hold the top 2 spots on Audio Defence. I usually beat most games but having graphics on an audio game letting Sighted people play with blind people is a great idea. (Eric, personal communication, April 3, 2018).

creative production project as an unstable 'coming to know' something through material or digital practices where the outcome and even the research question itself may not be fully understood until the project is concluded. On such a journey, one cannot assume a linear set of revelations. Janson (1967) suggests:

> The making of work of art has little in common with what we ordinarily mean 'making'. It is a strange and risky business in which the maker never knows what he is making until he has actually made it; or to put in another way, it is a game of find-and-seek in which the seeker is not sure what he is looking for until he has found it. (p. 11)

Tomas (1958, p. 4) puts it another way: 'To create is to originate. And it follows from this, that prior to creation, the creator does not foresee what will result from it'. Such uncertainty, although difficult to manage, becomes a valuable aspect of the inquiry, where movement in diverse directions can lead to new discoveries. Under such circumstances, in a creative production project, the researcher's open mind, critical reflection, curiosity, flexibility and perseverance are essential (Ventling, 2017) if the project is to constitute an original investigation that moves beyond accrued competence applied in sophisticated ways to a preconceived outcome.

4.2 Practice-oriented research

I use the term practice-oriented research to describe research that pursues an effective or novel outcome or insight through a process of 'coming to know' via practice. This 'coming to know' requires reflection on both the research process and emerging outcomes emanating from the practice.

Ventling (2018) suggests that such research is distinguished by a 'dynamic relationship where research and art practices work and develop in partnership' (p. 124). At the heart of such inquiry, Mäkelä and O'Riley (2012) suggest, 'lies the undeniable curiosity of the artist or the designer' and at the beginning the researcher's questions might be unstructured and vague (p. 8).

Ventling (2018) suggests that this type of research requires a substantial level of personal engagement because it challenges perceptions and existential boundaries. In such inquiry, the practitioner engages in a reciprocal process that:

> influences, and is equally influenced by, the artist's self. The researcher is led into unknown territories both outside and within, reflexively reshaping assumptions and the course of exploration. As the investigation develops, so does the self of the investigator. (p. 125)

Juul (2019) and Michael (2003) suggest that the necessity of personal engagement, and a connected exterior and interior journey of the self (based on exploration through, and reflection on, practice), are fundamental to indie design/development. These are also features of heuristic inquiry.

4.3 Heuristic inquiry and the Indie Designer/Developer

Indie Designers/Developers utilise questioning as an agent in discovery because they generally work independently, outside of a prescribed formula or research template. Here, both tacit and explicit knowledge are brought to bear on the iterative development of work (Hill-Whittall, 2015; Juul, 2019; Michael, 2003; Schwarzl, 2014). Given these features, it is useful to consider the nature of heuristic inquiry as a methodology.

Heuristic inquiry[122] offers a qualitative framework for solving a problem for which no formula exists (Ings, 2011). It acknowledges that an independent researcher might employ intuitive decision-making, iterative self-reflection and a combination of methods to assess and advance a particular study. Accordingly, it can be well suited to certain kinds of artistic, practice-oriented research (Ings, 2011; Ventling, 2018).

Schön (1984) describes heuristics as a journey guided by metacognitive knowing, self-learning and self-discovery. His term 'reflection-in-action' describes the processes of doing and thinking where, 'doing extends thinking in the tests, moves and probes of experimental action, and reflection feeds on doing and its results. Each feeds the other, and each sets the boundaries for the other' (p. 280).

[122] 'Heuristics' comes from the Greek word *heuriskein* meaning 'to discover' or 'find' (Ings, 2011).

Moustakas (1985) defines heuristic research as a 'search for the discovery of meaning and essence in significant human experience' (p. 40). In 1990, he identified core processes of a heuristic inquiry that included the researcher's identifying with the focus of the inquiry and the use of self-dialogue, tacit knowing, intuition, indwelling and focusing, all of which function within an internal frame of reference. Ings (2011) suggests that:

> Heuristics relates to the ability to find knowledge, patterns or a desired result by intelligent, informal questioning and guesswork rather than by applying pre-established formulae. As a form of inquiry, it utilises sophisticated levels of informed subjectivity and tacit knowledge to solve complex creative problems. (p. 227)

Ventling (2018) defined nine aspects of heuristic inquiry in relation to practice-oriented artistic research (see Table 4.2, column 2). My reflections on these aspects as an Indie Designer/Developer are summarised in column 3 of Table 4.2.

Table 4.2.
Summary of features of heuristic inquiry in relation to practice-oriented research

Features of a heuristic inquiry	Ventling's (2018) interpretation	My reflections from the perspective of an Indie Designer/Developer
The research question	The question at the outset is personally significant and existential. As such, the question is often not a problem that can be neatly solved, but an issue that calls out for immersive contemplation and reflective probing. It may be something that the researcher feels is incomplete, unclear or disassociated, and demands to be clarified. Often, the concern is not only compelling to the artistic researcher but holds a universal significance or deep social meaning (p. 130).	I did not have a specific research question at the outset of the project. I was concerned by the complaint of a blind gamer who told me, 'Nobody makes games for us'. Accordingly, I was driven by the need to make high-functioning, quality games for blind or visually impaired players. I felt that these games could be more effective than those that currently existed. As the research advanced, I asked myself, 'What are the main issues that will need to be addressed if I am to create effective games for non, or partially sighted players?' However, this question emerged from a 'concern' that was the initiating point of the project.
Reflection and the self	Reflection is the process by which the researcher identifies and clarifies the meaning of experiences in relation to the self.	As an Indie Designer/Developer, I constantly reflected on the experience the games I designed and developed.

Features of a heuristic inquiry	Ventling's (2018) interpretation	My reflections from the perspective of an Indie Designer/Developer
	The person creating, responding to, and working on, developing or evaluating artefacts and practices is central to those activities. An artistic researcher cannot be anything but personally involved and deeply invested in the research (p. 131).	There was a high level of reflection on initial concepts, iterative prototypes and feedback from games I posted online. I asked myself what was done well and what could be improved. I was also concerned with self-improvement as a designer/developer. (So, I reflected on how I was acquiring emerging knowledge about game design and development, how as a researcher I might apply entrepreneurial approaches to design and dissemination, how I could become even more attentive to blind gamers' experiences, how I might function as a more effective leader of a team, and how I might be enhanced as a researcher by attending conferences and reading new material.) I was personally committed to the project, treating the initiative almost as my child.
The tacit dimension	'We can know more than we can tell' (Polanyi, 1967), and it is this form of knowing that the researcher utilises in the research. If researchers are to seek meaning from experience, then they must dwell in this sensate encounter in anticipation of what might be drawn into conscious awareness (p. 131).	I relied on tacit knowing heavily. Such knowledge was drawn from life experiences as a competitive athlete and years of playing online games. Much of this knowledge was 'sensed' and it enabled me to 'feel' when an idea held potential or resonance.
Authentic commitment	Heuristic research is not casual; it is an approach that requires high levels of self-reflection to drive the questioning deeper. Sela-Smith (2002) describes such an immersive investigation as a 'leap into the unknown'. Although this may destabilise the researcher emotionally, the desire for new insights must be greater than the fear of risk, propelling the researcher to submit fully and authentically to the exploration (p. 132).	I was heavily committed to the project. I left a stable life in Poland in pursuit of research and development opportunities. I sacrificed my social life and lucrative employment. I generally worked 60–80 hours per week on game design and development, often managing on a minimum salary or no income at all. I lost personal relationships. Moving to Germany and later to New Zealand was an enormous 'leap into the unknown' for me, but I was deeply committed to the

Features of a heuristic inquiry	Ventling's (2018) interpretation	My reflections from the perspective of an Indie Designer/Developer
		project. I felt a profound responsibility to it.
Practical experience	Heuristic research 'invites the conscious, investigating self to surrender to the feelings in an experience. As the practice unfolds, experiences with materials, processes, dynamics and spaces are generated. Through deliberation and intuitive sensing, the researcher attempts to find combinations, resonances and insights, and these in turn edge the practice into further experiences. This experiential learning leads to growing self-awareness and self-discovery (pp. 132–133).	I used accrued practical knowledge gathered throughout my life. (I have played multiple games and worked on several software development projects. I also established a start-up company.) In creating the *Audio Game Hub* and *Blind Cricket*, I followed intuition and gained substantial new practical knowledge and experience.
Driven by process	Persistent questioning is habitual to the process. This involves a dynamic and intricate engagement between the practice and the self, the creating and the reflective thinking, with each stimulating the other as the work and the discoveries unfold. As the inquiry unfolds, the research question may morph into various iterations. Accordingly, the dynamic pursuit, rather than a pre-determined objective, becomes the driver of the inquiry (p. 133–134).	The project was driven by a dynamically changing process. I questioned what I experienced and the process itself became autotelic. Reflecting on this now, the joy and fulfilment of the project resided primarily in designing, creating, spending time with collaborators, preparing for launches and collecting feedback from users' and reviewers' postings online.
Trial and error exploration	Discoveries can be unpredictable and these may reveal new directions. Heuristics deals with this motif, not by pre-determining a path, but by allowing one to unfold progressively. 'What works' becomes the focus, and anything that makes sense can be tested. What succeeds becomes 'the right thing' (p. 134).	I often used trial and error while probing multiple ideas, concepts and designs. Many initial assumptions did not work and had to be changed or abandoned. However, there were also many unpredictable discoveries that emerged when I found myself forced to rethink 'errors' within a design.
Recurring external exchange	Heuristic self-reflection may limit critical thinking if it becomes isolated to the artist's self and their own terms of reference.	Although Sela-Smith (2002) cautions against opening a heuristic inquiry up to outside review, like Ventling (2018) and Ings (2011), I found it

Features of a heuristic inquiry	Ventling's (2018) interpretation	My reflections from the perspective of an Indie Designer/Developer
	Therefore, at distinct stages, the researcher must turn outward to external exchanges where there is provision to engage with, and be stimulated by, multiple perspectives and differing opinions. This exposure is valuable academically and personally because it may lead to increased awareness, recognition and elaboration of relating connections, contextual themes, overarching principles, procedural knowledge and differing approaches (p. 135).	useful to seek feedback, but then to draw it back into the broader context of the project. Consequently, I often thought of feedback as provocations to my existing principles and perspectives, rather than just suggestions for tweaking of something specific. This meant that feedback often caused me to re-invent or fundamentally modify the games, or to change my approach to thinking and development. Many suggestions from the blind and partially sighted community influenced design and development of future games and increased my awareness about visual disabilities in the field of gaming.
Perspective shift	As new meanings are discovered through the research, these may lead to a shift in perspective, revised beliefs and a new sense of self. This may not only influence the future research, but also have larger social and transpersonal implications. Although each heuristic inquiry is unique and individualised, uncovered meanings can nevertheless be exchanged and compared (p. 135).	I experienced significant perspective shifts multiple times during or after development phases in the research. For example, my approaches to design were altered as I came to understand visually impaired gamers' playing habits. For example, they are actually very comfortable using touch screen devices but often do not hold the device in their hands in a vertical position because they have no need to look at content; instead, they generally engage with the device horizontally while it is lying on a surface. This insight caused me to reorient my thinking and include screen orientation in the *Audio Game Hub* instructions.

Hiles (2001) described heuristic inquiry as 'an extremely demanding process, involving disciplined self-commitment, rigorous self-searching and self-reflection, and ultimately a surrender to the process' (para. 6). He also stresses the 'need for the researcher to feel passionate about the research question' and suggests that in heuristic inquiry there is a transformative effect on the researcher's experience (para. 9). His position here resonates with the nature of the Indie Designer/Developer who operates with very high levels of disciplined self-commitment, functions with limited resources and is passionately

associated with the inquiry (Michael, 2003). Like the heuristic enquirer, Indie Designers/Developers also operate in a state of uncertainty by constantly asking questions (Juul, 2019) and they have to remain open to and adapt to changes.

In conventional game design, AAA designers and developers often know and follow rules or established 'best practices' to achieve strategic outcomes (in other words, they may use pre-established templates of existing knowledge). Conversely, an Indie Designer/Developer leans more heavily on accrued tacit and explicit knowledge that is applied in a process of dynamic questioning through processes of trial and error.

Having discussed the features of heuristic inquiry underpinning my Indie Designer/Developer approach to the project, I will now discuss specific methods employed in its explication.

4.4 Methodological framework and processes

The processes in the inquiry may be grouped into three phases: ideation, prototyping and artefact refinement. Contributing to the ideation and artefact phases is a process of external feedback and review (see Figure 4.1).

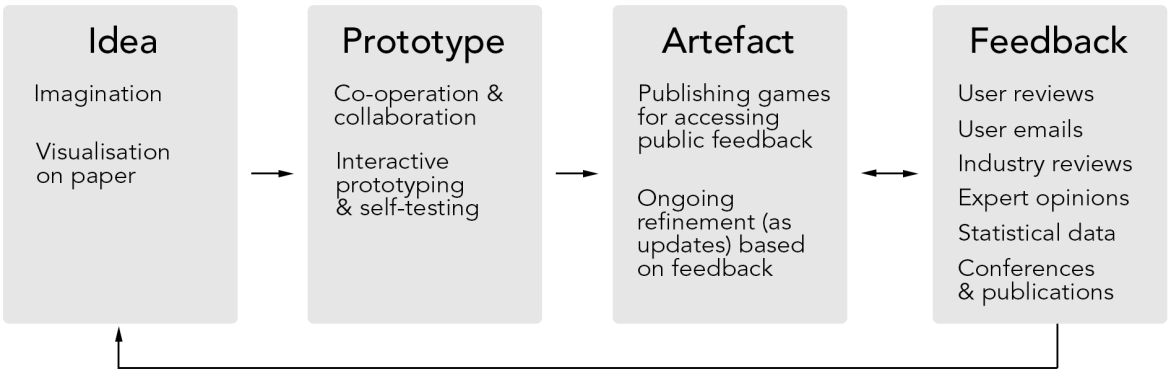


Figure 4.1. The research phases of the inquiry. External feedback creates a loop of information that resources both artefact refinement and new ideation. © Jarosław Beksa.

4.4.1 Phase 1: Ideation

Imagination

At the outset of a design, I imagine game mechanics and what it would be like to play a game on a touchscreen device. Such imagination is multisensory. I imagine (visualise) the layout of objects (e.g., buttons), I 'hear' accompanying audio and I 'feel' haptic feedback. I often enhance imaginative processes by making changes to my physical world like blindfolding myself or closing my eyes. This is done to increase my sense of embodied experience.

Visualisation on paper

Following this process, I create sketched mock-ups[123] of a touchscreen smartphone. These drawings normally contain game and menu objects (see Figure 4.2). These visualisations are used as a communication tool between the designer (me) and programmers (other team members). Often these drawings include multiple screens, enabling people collaborating in the project to visualise alternative proposals or game flow and stages. Thus, the sketches enable a team to design and think through 'step-by-step' or 'action-by-action' proposed game behaviour.

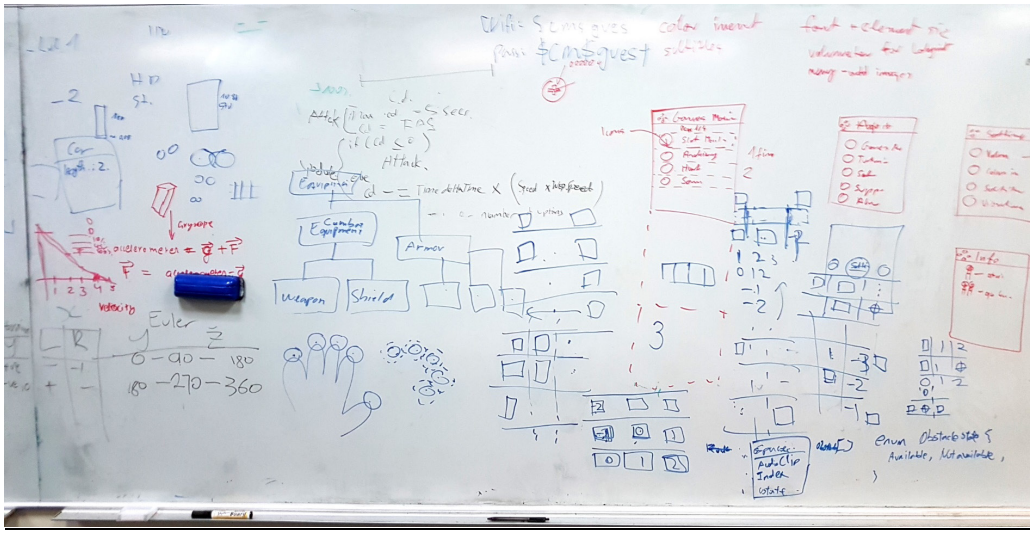


Figure 4.2. Example of visualisation on whiteboard. This visualisation shows the design of the gesture interface and main menu elements in *Audio Game Hub 2.0*. © Jarosław Beksa.

[123] A mock-up is a scale or full-size model of a device or design used for demonstration, evaluation or discussion. It can be differentiated from a prototype because the latter provides some of the functionality of a system.

To address my unreadable handwriting and unclear sketching, my initial visualisations are normally converted into a digital rendering[124] using prototyping tools (applications) such as *Pencil Project*[125] (Evolus, 2008) or *PowerPoint*[126] (Microsoft, 1987) (see Figure 4.3).

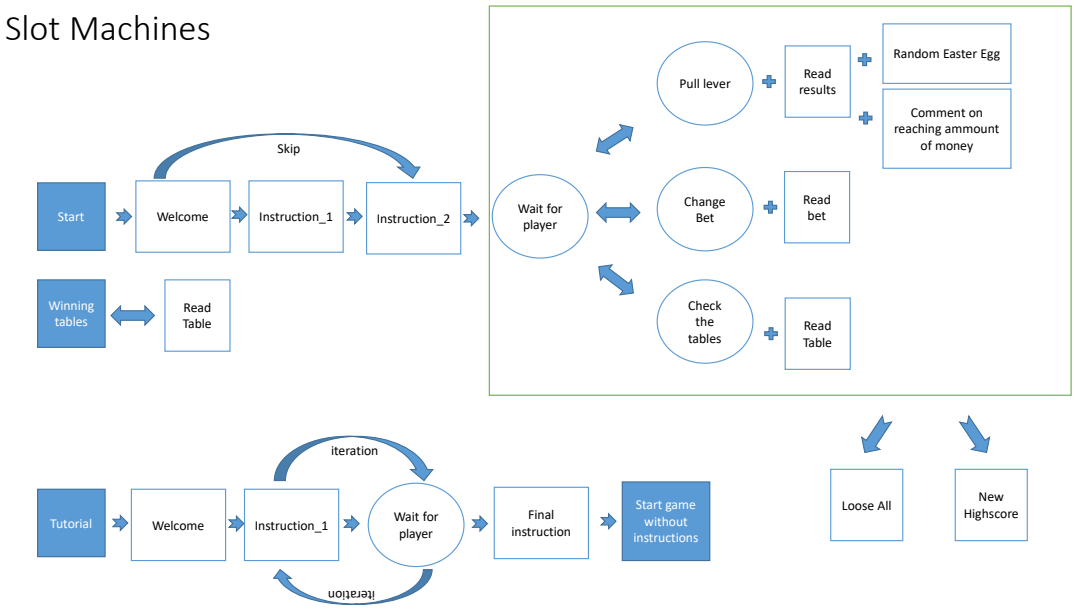


Figure 4.3. An example of a digital rendering of game flow (for *Slot Machine*). © Jarosław Beksa.

4.4.2 Phase 2: Iterative prototyping and testing

Co-operation and collaboration

Although I was responsible for design, sound engineering and testing in this project,[127] I also sought the collaboration of specialists for coding and graphic design. I use the word 'collaboration' as differentiated from co-operative inquiry. Co-operation involves the allocating of specific needs within the project to individuals. Here there is a 'division of labour among participants […] where each person is responsible for a portion of the problem solving' (Roschelle & Teasley, 1995, p. 70).

However, collaboration is comparatively a more dialogic process where 'practical support, criticism, encouragement [and] ideas are open to exchange and sharing' (Gray, 1996, p.

[124] Digitally rendered examples of *Audio Game Hub* games flow design are presented in Appendix B.
[125] https://pencil.evolus.vn/.
[126] https://www.microsoft.com/en-us/microsoft-365/powerpoint.
[127] As well as project and team management, marketing and promotion.

12). Although within the teams I build there was respect for specialist skills, I try to emphasise that we are a 'family' and the project is not atomised into discrete non-discursive factions. We co-habit the same spaces, eat and play games together, promote the project as a team and together talk through and find ways of addressing online feedback.

Iterative prototyping and self-testing

Working with the project's team members, we design solutions 'physically'. By this I mean we create prototypes through an embodied process (we try to physically empathise with a potential player) – I simulate blindness and I 'play' my way through iterative refinements. This process may be understood as a form of embodied experimentation. When I work this way, I am cognisant that Araújo et al. (2017) discuss the challenges that sighted game designers/developers, who unfamiliar with the needs of visually impaired players, must confront. Given my limitations in this regard, I developed heightened attention to feedback and appreciation towards the value of ongoing discussions and game playing with non-sighted friends and advisors.

I find that when making prototypes there is a kind of an experiential memory (tacit knowing) that becomes very active. As a prototype refines, I mentally talk with it and it talks back to me. I ask it what needs to be improved and it calls to its accrued knowledge. If such knowledge is unable to address a question at hand, I will talk with the team or seek expertise from somebody with technical expertise or insight.

4.4.3 Phase 3: Artefact development, publishing and refinement

Publishing games for accessing public feedback

Once prototypes have been created and tested, the games are published on supported platforms (iOS and Android) and are opened for public feedback through relevant application stores like App Store and Google Play Store.

Ongoing refinement (as updates) based on feedback.

Based on collected feedback (see Phase 4), games are refined and re-published with free updates made available to the users on their devices through the application stores. This

process creates a feedback loop in the project, so users not only experience the responsiveness of the designer but the project team are also offered critique (at no cost) based on the latest iterations of the games.

4.4.4 Phase 4: Feedback

Feedback is not considered terminal. In my work, I conceive our game designs as living artefacts that carry two embedded questions: 'What is working?' and 'How can it be improved?' As illustrated in Figure 4.1, published games reside in a cycle of provision and response. This being said, feedback also resources Phases 1 (ideation of new games) and 2 (iterative prototyping). In this project, the feedback took six distinctive forms: user reviews, user emails, industry reviews, expert opinions, statistical data analysis, and feedback elicited from conferences and publications.

User reviews

User reviews are pivotal to the refinement of the games we created. Suggestions and feedback in the form of comments and reviews are normally posted on Google Play Store[128] (Google LLC, n.d.-a) or Apple App Store[129] (Apple Inc, n.d.). In the first two years (from 15 April 2016 to 21 June 2018), *Audio Game Hub* received over 1,100 ratings and over 500 reviews. The vast majority of these were positive (4.7 out of 5 stars), but I paid the most attention to negative feedback, because this was useful for creating future improvements.[130]

Another source of user reviews were the community forums of blind gamers, such as Audiogames.net[131] and AppleVis.com.[132] Some users also contacted us by using social media channels such as Facebook[133] and Twitter.[134]

[128] https://play.google.com/store/apps/details?id=com.AUT.AudioGameHub&hl=en.
[129] https://apps.apple.com/us/app/audio-game-hub/id1101972684.
[130] A selection of user feedback and reviews is presented in Appendix D.
[131] https://forum.audiogames.net/topic/22424/ios-audio-game-hub-20/.
[132] https://www.applevis.com/apps/ios/games/audio-game-hub.
[133] https://www.facebook.com/audiogamehub/.
[134] https://twitter.com/audiogamehub?lang=en.

User emails

After publishing the games, I received hundreds of e-mails from users. As part of the publishing process, I included my contact details so this avenue for feedback was available and encouraged. I replied to all correspondence that contained feedback and descriptions of user's experiences while playing the games.[135]

Industry reviews

A third form of feedback occurred in industry reviews. The games were reviewed by many people, both in the gaming industry and in the wider community (game reviewers, journalists, gaming publicists, etc.). Reviews took the form of online articles, podcasts and video reviews (e.g., YouTube).[136]

Expert opinions

During the project, I also sought out expertise and critique from individuals like game accessibility specialist and advocate Ian Hamilton.[137] He reviewed the *Audio Game Hub* and proposed specific changes to improve games' accessibility rating (such as implementing an adjustable text size and a high contrast mode). His advice resulted in a higher accessibility rating on the Accessibility Foundation website.[138]

In 2016, in Poland, I met Tomasz Tworek who is a legally blind professional game tester, musician, sound engineer, gaming accessibility advocate and radio presenter.[139] Tomek had played the *Audio Game Hub* upon release and offered feedback on both the games and user interface. Since this time, Tomek has continued to share his feedback on the games through personal communications with me (e-mail, Skype and telephone discussions).

[135] Extracts of emails received during the project are presented in Appendix D.
[136] Examples of industry reviews are presented in Appendix E.
[137] http://ian-hamilton.com.
[138] http://game-accessibility.com/game/audio-gamehub/.
[139] https://www.radiodht.com/redakcja/.

Statistical data analysis

I also utilised statistical data analysis as a form of feedback. Throughout the project and as I move forward into future research, Google Analytics,[140] Facebook Analytics[141] and Firebase Analytics[142] prove useful in providing data related to user activity inside the applications. In the project, these analytics solutions were used to collect information such as gender, age, country of residence, device(s) used, user behaviour (specifically, how users spend time with the application) and whether the user was sighted or visually impaired. Detailed information is provided in Appendix E.

Conferences and publications

I attended, and continue to attend, relevant conferences. I also publish in professional and academic journals. During the project, the *Audio Game Hub* concept, its development progress and results were presented at four conferences and published three times.[143] Presenting at conferences and writing proceedings papers and articles was useful because it forced me to order and clarify my thinking so my ideas could be communicated in succinct ways. Conferences and publications also helped to extend my network of scholars and experts in the field.

4.5 Critique of methodology

Given the protean nature of the heuristic inquiry applied to the practices of an Indie Designer/Developer, in closing this chapter it is useful to consider the strengths of the methodology, challenges it presented and how these were navigated.

4.5.1 Advantages

Working beyond the established

To work heuristically as an Indie Designer/Developer, I utilised accrued, explicit and tacit knowledge to navigate uncertain trajectories. The methodology proved fertile because it

[140] https://analytics.google.com/analytics/academy/.
[141] https://analytics.facebook.com/.
[142] https://firebase.google.com/docs/analytics.
[143] For more detail see Appendix E.

caused me to think beyond templates and to ask questions of what I was encountering. In this regard, I found it helpful to draw on Kleining and Witt's (2000) guidelines for optimising the chances of discovery in heuristic inquiry.

First, like those authors, I found it useful to attitudinally remain open to new concepts and opportunities. This meant being willing to change my preconceptions about how knowledge and feedback might be accessed and synthesised. At the beginning of the PhD project, I had to change the way I tested ideas because there was no funding to conduct trials and experiments. Accordingly, I opened the artefacts to the public and relied on the generosity of people providing online feedback.

Second, Kleining and Witt (2000) note that in heuristic inquiries 'the topic of research is preliminary and may change during the research process. It is only fully known after being successfully explored' (p. 2). This was true of the present study. While the project's motivation (to make effective games for blind and visually impaired players) remained consistent, often the research questions shifted.[144]

Third, Kleining and Witt (2000) argue that if a heuristic inquiry is to heighten the chances of discovery, the researcher must be prepared to work with diverse variations of perspective. This, they suggest, means constantly looking outwards so one avoids one-sidedness. To enable this, in the project I sought to actively 'trouble' my established work practices by embracing limitations as opportunities. Compared to my previous corporate projects, this thesis project operated on a significantly smaller budget. This forced me to seek out new ways of securing funding and assets (e.g., crowd funding platforms like Kickstarter and securing discrete funding from the university in the form of single-purpose grants). On the other hand, not working for a big corporation afforded me comparative freedom and allowed for deeper levels of experimentation with different methods and approaches to design, development and publishing. My perspectives were also changed by the nature of the inquiry because the chosen feedback systems embraced a more personalised connection with users. In much industry-based game design, one is dealing with users as a collective (often formatted as statistical data). Operating heuristically, as an Indie Designer/Developer, my thinking was constantly being resourced by the human dimension

[144] For example, after noticing how sighted users struggle to play the games with no visual interface, I asked if it is possible to create an interface that could be attractive and easy to learn for both sighted and non-sighted players.

of what I was producing. Through personal feedback conduits, I came to understand the design of my games as something that permeates diverse personalised lives and contexts. I understood how effectively game design can become part of how personal relationships are built (see fn. 121 and 122 above and the email correspondence in Appendix D). I understood the joy of empowerment that effective game design can deliver in the context of an individual's life.

Finally, as the research developed, I adopted a proclivity for seeking out patterns in what I was discovering. In other words, my analysis was directed toward locating 'similarities, accordance, analogies or homologies within diverse and varied data' (Kleining & Witt, 2000, p. 2). I adopted an approach where I would connect ideas or approaches that might not normally be considered to see what might happen.[145]

Kleining and Witt (2000) suggest that a heuristic researcher is able to assess the effectiveness of unusual pattern connection by examining the richness, 'inner-validity' (p. 3), novelty, functionality and continuity of experience within the solution. I was able to determine how valued the outcomes of my thinking were by examining how gamers spent time with the app, including how often and when they played a game, how long each session lasted, which game screens they visited most often and which buttons and menus they activated (Google LLC, n.d.).[146]

4.5.2 Challenges

Limited resources

Resourcing in large commercial game-making organisations is very different to that available to me in this project. Given the paucity of funding and access to IP-protected research and development facilities, I had to resynthesise knowledge I had accumulated and independently apply it to new circumstances. Where I had no money to invest, I invested time and explored alternative funding sources such as grants, innovation

[145] An example of this can be illustrated by an initiative to implement video advertisements as a monetisation method in *Audio Game Hub 2.0*. I wanted to find out how people who are blind would interact and react to visual ads and if this method of monetisation could be effectively attached to audio games. More detailed information on this issue is discussed in Section 5.4.
[146] Google and Facebook Analytics also resourced me with information about devices and operating systems used, and information relating to users' gender, age and current country of residence.

competitions, start-up accelerators and crowdfunding. Often, people would join the team solely because of the project mission and the joy of making games.[147]

Time and relationships

Working on this project heuristically cost a great deal of time and energy. Instead of spending hours with friends and family, or engaging in leisure activities, I was often working 12 hours a day including weekends and public holidays. This had a significant impact on my personal wellbeing and relationships and resulted in a kind of 'voluntary' isolation. However, being immersed in a flexible heuristic form of game creation kept me constantly in a flow state (Csikszentmihalyi, 2008), and, increasingly people with whom I was working on the project became my friends and surrogate family.

Uncertainty

Heuristic enquiries are often described as generating 'uncertainty' (Moustakas 1990; Ings 2011; Sela-Smith, 2002; Ventling 2018). Prior to this project, I had worked with companies where practitioners generally utilised and applied fixed data and templates of existing knowledge. Here the emphasis was often on strategic application or minor adaptation of proven effectiveness. Conceptually, a heuristically oriented Indie Designer/Developer does not have the certainty and security of templates or predictable trajectories. Often, they must commit to chaotic movements or 'leaps of faith' to find a way forward. Actions can encounter a low chance of success because one is often navigating the unknown. But there is something intriguing and attractive in such pursuit. Moustakas (1990) described this as follows:

> I begin the heuristic journey with something that has called to me from within my life experience, something to which I have associations and fleeting awarenesses but whose nature is largely unknown. In such an odyssey, I know little of the territory through which I must travel. But one thing is certain, the mystery summons me and lures me to let go of the known and swim in an unknown current. (p. 13)

[147] An example of this is Jeong Su Jeon who became the lead *Audio Game Hub* and *Blind Cricket* programmer. His commitment to the project was not driven by its potential financial benefits. His commitment was such that when we ran out of funds he worked for free on the project. A more detailed discussion of the formation of the development team is presented in Section 5.1.1.

In dealing with the uncertainty of being an Indie Designer/Developer, I reminded myself of the inherent excitement and lure of working in areas where there was no existing answer.

Losing momentum and focus

Finally, because of the complexity and instability of a heuristic inquiry, a researcher can face long-term uncertainty and slow progress. I confess that at times I risked losing momentum during the project. I understand that not getting things right the first time is sometimes the cost of doing something really well. To address a potential loss of momentum and a diminishing of tenacity, I read books about people who have struggled to become successful. I was able to identify with their failures and also remind myself that bringing certain things into realisation requires unreasonable commitment and strength. In addition, I tried launching parallel initiatives that might reap temporary rewards.[148]

However, beneath such strategies lay an ongoing necessity to reconnect with the purpose of the project. The *Audio Game Hub* games were driven by a need that was not abstract, but human. Real people wanted these games and they communicated directly with me. I knew the shape of anticipation and hope, and I knew the generosity of support that took the form of freely offered advice and insight. I knew there was relevance and purpose in what I was doing and when momentum flagged, I made a conscious effort to reconnect with this.

In this chapter, I have outlined the research design as a unique melding of heuristic inquiry and the nature of indie design/development. I have also discussed methods that were employed in the development and refinement of the audio games. In the next chapter, I consider the making and development of the games inside the PhD project.

[148] For example, while I was navigating the drawn-out process of investment in November 2016, I launched a crowdfunding campaign to fund development of *Audio Game Hub 2.0* to keep myself and the team motivated.

Development of the *Audio Game Hub* and *Blind Cricket*

Prior to discussing of the audio games themselves, this chapter describes how the tenets of indie design/development were manifest in approaches taken to team building, securing funding, development and refinement, publishing, marketing and monetisation.

5.1 Team building

When approaching a project as an Indie Designer/Developer, one tries to maximise both knowledge and goodwill. Teams are often small, but the level of commitment and tenacity necessary to realise projects is generally intense and focused on both outcomes and the inherent rewards of 'belonging' inside the project. Accordingly, how one builds and maintains teams of collaborators is very important.

I came to the project with a specific set of skills, including game design, sound design and project management. However, I was cognisant of the need for knowledge beyond these realms; thus, from the outset I sought out team members with advanced skills in computer programming and graphic design. Given the nature of the undertaking, I was looking specifically for people passionate about games; people who were willing to sacrifice their time and energy and commit to something that they felt was of value. I was also looking for collaborators who could work well both independently and within a team. In addition, I was seeking participants who might find joy in bringing something new, exciting and of value into the world. In essence, I was looking for other indie game developers (Juul, 2019; Michael, 2003).

I thought a good place to begin looking for such people might be the Auckland Game Developers' Meetup,[149] hosted monthly at Auckland University of Technology. At these events, participants have an opportunity to take the stage and make an announcement. I pitched the *Audio Game Hub* idea and there were six people interested in participating in its development. During the project launch meeting (on 11 August 2015), I explained the nature of the initiative with its emphasis on research, indie approaches and a limited budget. As a team, we agreed that the first working week would be a non-paid trial to ensure that the team members could work well together. After this week, only three collaborators remained: Serge Rajinovich, Austin O'Brien and Jeong Su Jeon.

[149] https://www.meetup.com/aklgamedev/.

Serge was a third-year university student experienced in games programming using the Unity 3D engine. Austin was a talented graphic designer and programmer who was completing his second year of degree study. Jeong was a graduate who had just begun his programming journey. Over four months of intense work, this small team managed to completely re-develop the *Audio Game Hub 1.0* prototype. Our initial budget ran out in December and Serge and Austin began pursuing other jobs. By the end of January 2016, Jeong and I were the only members left in the team.

5.1.1 Commitment: Jeong Su Jeon

Jeong was the most important person in the *Audio Game Hub* and *Blind Cricket* projects, coding over 90% of the applications. Although Jeong did not have a significant amount of game development experience when he joined the team, he was deeply committed to the values of enablement that underpinned the project.

I was often reminded, when working with collaborators like Jeong, of Steve Jobs who once said:

> In software [development], the difference between the average and the best is 50 to 1, or maybe 100 […]. I built a lot of my success off finding these truly gifted people and not settling for B and C players, but really going for the A players. […] I found that when you go through the incredible work to find five of these A players, they really like working with each other, because they have never had chance to do that before. And they don't want to work with B and C players. (Jobs, n.d., 0:42)[150]

Zolotaryov (2016) identifies A-programmers as individuals who:

> have a passion for programming. They read about their work, they share it readily in conversation with their peers and in writing (e.g. in the comments section of Hacker News), and their personal time is taken up with improving their abilities. When A-class programmers work together, the value of their creation is more than the sum of their abilities. Most importantly, A-class programmers go above and beyond the status quo. (para. 28)

Jeong was an A-programmer, and in my mind he met another essential criterion of an Indie Designer/Developer: income was never his primary motivation. In truth, throughout the

[150] https://www.youtube.com/watch?v=wTgQ2PBiz-g.

project, we both only took the minimum New Zealand wage. There were also months (when the project was out of funds) when we received no salary at all, but Jeong still remained motivated. He continued to believe in and dedicate himself to the project. Jeong's commitment was such that he proposed finding a part-time job to cover his salary. Such an exceptional level of dedication and belief is what defines an Indie Designer/Developer and a true friend (see Figure 5.1). Such commitment is humbling and had a profound influence on how I came to think about leadership. I was reminded constantly that in independent projects, it is our collaborator's shared sense of the inherent value of the indie design process that shapes individual and collective commitment. In such instances, leadership is not something predicated on charisma but rather on a deeper drive to nurture a sense of belonging to an idea and to embody devotion to its growth and realisation.

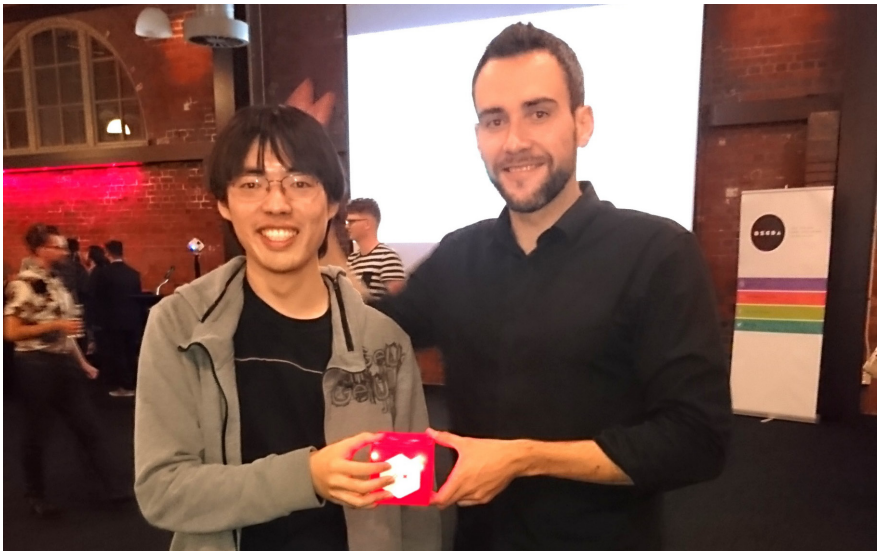


Figure 5.1. Jeong Su Jeon (left) and Jarek Beksa (right) at the Play-by-Play 2016 awards ceremony. © Jarosław Beksa.

5.1.2 Building a family

Hill-Whittall (2015), Juul (2019) and Michael (2003) all note that indie game developers are normally less aligned with a company and more with a project. Since independent projects often have to navigate relatively uncharted trajectories, they can be unstable, uncertain and unpredictable. They can also require significant commitment, long working hours and an insecure income (Swirsky & Pajot, 2012). However, because indie teams are often small, team members have the opportunity to become close to each other. In this project, this closeness took the form of a surrogate family. Partially this may have been because a closely connected team, driven by common values, is capable of generating internal systems of

'belonging'. This quality enables a team to more successfully navigate adversity and collective opportunity.

Three approaches to building a family were particularly significant. First, I endeavoured to make our work and time we spent together fun. We met every day in one of the university labs and we arranged the tables in a square so everyone could see each other and communicate directly. Often, after work, we would play games together.[151] This initiative reinforced our commonality; it drew on what connected us (games) and expanded our preoccupation with design and development into the joy of playing together.

Second, every day I would order pizzas for the team. It became our tradition, after a hard day of work, to always celebrate by eating together (see Figure 5.2).[152] This is not an unfamiliar principle in New Zealand. The concept of *manaakitanga* (nurturing relationships and caring about how people are treated) is a key component of Māori culture. Underpinning all tikanga Māori,[153] *manaakitanga* encourages people to rise above their personal attitudes and feelings towards others. Resourcing this is the idea of being hospitable, including the sharing of food as an integrated part of growing a strong community (Keane, 2013; Mead & Mead, 2003). This was not an unfamiliar concept to me. In Poland, I grew up in a family where we always ate together, and I understand that sharing meals is a way of reinforcing unity. As an extension of this, I also tried to celebrate the team's milestones and successes together. This often took the form of food and drinks in our lab, although sometimes (if we could afford it), we would venture out to a restaurant (see Figure 5.3).

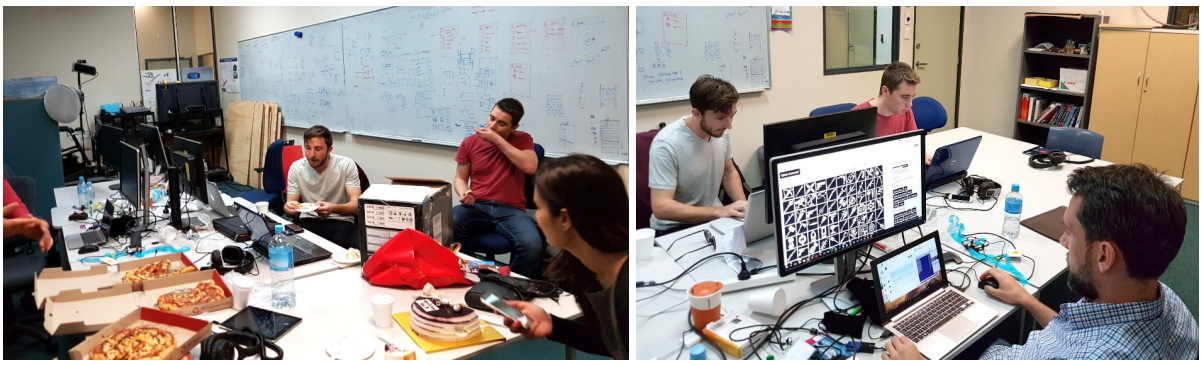


Figure 5.2. The *Audio Game Hub 2.0* team working in the HCI Lab. Celebrating a team member's birthday (left) and a typical workday (right). © Jarosław Beksa.

[151] Usually *Starcraft 2* (Blizzard Entertainment, 2010) or *Counter Strike* (Valve Corporation, 2000).
[152] We playfully counted how many pizza slices were consumed and posted this information on the project's website at http://www.audiogamehub.com/ (The last reading showed 1,443 slices).
[153] Māori values.

Figure 5.3. The *Audio Game Hub 2.0* team celebrating the successful Kickstarter campaign in 2016 at the Orbit restaurant in Auckland, New Zealand. From the left: Vincent Polewidhi, Jeong Su Jeon, Jarosław Beksa, Mitali Purohit and David Delgado. © Jarosław Beksa.

Although eating together is an external expression of *manaakitanga*, the family also supported each other's growth and development. Distinctively, this support took the form of knowledge sharing. There was no template for how this might be done, but a culture of generosity operated that was non-hierarchical and predicated on sharing and celebration. Team members voluntarily helped each other or formed sub-teams to solve problems that we encountered.

The sense of shared generosity was a quality Davis, Allen and Hayes (2010) found in their analysis of family members employed in family firms. Their study indicated that people who perceive themselves as being part of a 'family business' reported higher levels of perceived ownership and agency compared to non-family members. Their study found that trust, value commitment and agency were related to perceptions of stewardship and that people who perceived themselves as 'family member employees' related these qualities directly to enhanced levels of commitment and performance (Davis et al., 2010).

5.1.3 Ensuring recognition

Although consciously reinforcing internal support systems was integral to building an effective team culture, this was resourced by an attitudinal position predicated on shared recognition and attribution. The American philosopher John Dewey argued that the primary need in human beings is to feel valued:

> It often seems to me that it is the deepest urge of every human being, to feel that he does count for something with other human beings and receives a recognition from them as counting for something. (1984, p. 239)

Organisationally, Dewey's idea lies deeply embedded in post-heroic leadership models (Eicher et al., 1999; Huey & Sookdeo, 1994). In their analyses of companies that operate with flattened structures and distributed responsibility, these researchers noted a discernible movement away from singular 'heroic' leadership models, where success is normally claimed back by the highest positional leader. In their analyses of post-heroic organisations, they observed that this alternative form of leadership resulted in the retention of innovative people because innovations and insights were attributed directly to the individuals or teams that generated them.

I would argue that such leadership may be differentiated from organisational management. Lush (2019, para. 1) suggests that people often confuse these states: 'Managers have staff, whilst leaders have followers. Both require similar qualities, including technical and interpersonal acumen, but these are not synonymous'. In differentiating a leader from a manager, Lush suggests five distinctive qualities:

- leaders create a future-focused vision, while managers tend to concentrate on goals
- leaders will 'sell' ideas, while managers tend to 'tell' ideas to a team
- leaders concentrate on building relationships, while managers focus on systems and processes
- leaders tend to be life learners, while managers rely on existing proven skills
- leaders will drive innovation and change, while managers will tend to rely on maintaining the status quo.

Lush's features of leadership were integral to how I tried to operate. Our team was driven by a vision, but we had to constantly adjust things in the face of adversity and the unknown. I tried to become a promotor and enabler of ideas who concentrated on relationship

building that would resource innovation and change. But in addition to these qualities, I understood the importance of people being valued for both their talent and commitment.

First, everybody involved in the project was recognised in the game credits and were mentioned in the 'about' section on the project's website. Team members also appeared prominently in marketing and promotion activities including crowdfunding promotional videos, interviews on the Internet, and features run in local newspapers and television (see Figures 5.4 and 5.6, Video 5.1, Section 5.4 and Appendix E). Wherever possible, we emphasised that the *Audio Game Hub* was created by a group of people, not an individual.


AUCKLAND CITY HARBOUR NEWS, NOVEMBER 23 2016

Gaming app for the visually impaired

CATRIN OWEN

A group of university students are getting international recognition for a video game app they designed for blind people.

Developed by PhD student Jarek Beksa, Audio Games Hub is a video game app that is designed to be played using audio rather than visual cues.

Beksa, originally started the project in Poland before moving to New Zealand to continue studying at AUT University in Auckland.

"Blind people seldom play games because they don't know there are games out there," Beksa says.

"When I first did tests in Poland the blind people were really sceptical but after a few minutes of playing there was huge smiles."

He joined forces with five other students from central Auckland who have worked tirelessly on creating the free app.

So far it has been downloaded 20,000 times by users all over the world. Beksa says the development process has taken nearly two years.

"At the beginning it was quite easy, we looked at arcade games for sighted people and we looked to see if it was possible to transfer it.

"We blindfolded ourselves to see if it was possible and when we thought the game was playable we went to people who were blind who decided if they were playable," he says.

Users rely on sounds, echo, effects and spoken word to carry them through the the various games including archery, block games similar to Tetris and labyrinth.

App developer David Delgado says the team had to overcome some obstacles.

"We're trying to provide an experience like no other for the blind community. We're pushing that boundary for audio games," Delgado says.

One user in Canada emailed Audio Games Hub after playing the game and shared his joy of being able to play games with his wife.

"You made possible something I thought I wouldn't ever see," the user said.

Launched in April, the app has picked up awards from global gaming events and been recognised by blind associations.

Due to an increasing demand for more games they have launched a Kickstarter campaign.

App designers Vincent Polehwidhi, David Delgado, Jarek Beksa and Jeong Su Jeon.

"We're trying to provide an experience like no other for the blind community."
David Delgado

Spice your

Indian-spiced lamb yoghurt is a tasty

YELLOW RICE

Ponsonby

Normal Trading Hours:

Figure 5.4. An article about the Kickstarter campaign in a local Auckland newspaper. From the left: Vincent Polehwidhi, David Delgado, Jarek Beksa and Jeong Su Jeon. © Jarosław Beksa.

5.1.4 Supporting futures

Inside the *Audio Game Hub* initiative, I also worked to actively support each team member's future. For example, when someone was applying for another job, I provided a recommendation letter or reference.[154] Although I wanted the project to be as richly resourced by team members as possible, I also understood that the initiative could not, in

[154] One team member, after the project was completed, told me that he secured a job at a local game development company thanks to the fact that the *Audio Game Hub* was part of his portfolio. His employer, he said, was impressed by both the project and the team member's commitment.

the short term, meet the necessities of a stable assured income. By investing support in people's futures (even though I knew we might lose them from the team), I believed that goodwill and care about people's aspirations would support the value of future indie initiatives beyond the perimeters of the *Audio Game Hub* project.

5.2 Securing funding as an Indie Designer/Developer

The *Audio Game Hub* and *Blind Cricket* could have not been created without the support and investment of individuals and institutions. Since this was an indie project, I could not rely on stable financing aligned with companies or corporations. Instead, I needed to operate in more flexible and unassured world of alternative funding. As such, the project had to be both agile and opportunistic, recognising potential resources and being able to 'pitch' its values and potential outcomes as an appealing investment. This required certain skills, including writing, presentation and public speaking. I also had to build trust with stakeholders, keeping them informed about our progress and being prepared to ask them for help and advice.

When seeking funding for indie initiatives, I found that it was important to be able to express the big picture; to be able to concisely articulate the 'why and what' of our project. I rapidly honed these skills and they became essential to the development of the project. Simon Sinek (2009) suggests that 'People don't buy what you do; they buy *why* you do it. And what you do simply proves what you believe' (4:28).[155]

5.2.1 Grants and investments

Over the course of three years, the total cost of the project exceeded 183,000 NZD. In this section, I discuss three ways I secured independent funding for the project:

- academic research grants and private investments
- crowdfunding
- engaging in parallel projects and employment.

[155] https://www.ted.com/talks/simon_sinek_how_great_leaders_inspire_action.

After obtaining official permission from the Gamification Lab to independently continue the development of the *Audio Game Hub* at Auckland University of Technology, I 'pitched' the initiative to Professor Stephen MacDonell,[156] Director of the Software Engineering Research Laboratory (SERL). He responded positively to the *Audio Game Hub* concept and offered 6,000 NZD of initial financial support.

My second pitch was targeted at Dr Robert Wellington, Director of the Human Computer Interaction Lab. He generously offered his lab for game development purposes. This solved the significant problem of organising and covering the costs of office space rental and gave the project access to important IT infrastructure and software.

My third pitch was delivered on 9 December 2015, at the annual AUT Innovation Challenge (see Figure 4.5). I presented the idea of interactive audio stories for people who are blind and the concept won first prize[157] (5,000 NZD). This event provided me with some additional budget, but it also opened up new networking opportunities and enhanced my credibility within the academic environment. Through the recognition the award offered, I accessed an opportunity to meet with the CEO of AUT Ventures (formerly AUT Enterprises Limited), Kevin Prior.

Figure 5.5. AUTEL Innovation Challenge awards. From left: Professor John Raine, Jarek Beksa and Ross Peat. © Auckland University of Technology. Used with permission.

[156] https://www.aut.ac.nz/profiles?id=smacdone&asset=270526.
[157] https://www.facebook.com/autuni/photos/congratulations-jarek-beksa-winner-of-the-autel-innovation-challengejarek-develo/1190554574292344/.

My next 'pitch' was delivered to Mitali Purohit, Commercialisation Manager at AUT Ventures Ltd.[158] This presentation resulted in an additional 10,000 NZD for the *Audio Game Hub*'s development and promotion. This investment (and winning the Innovation Challenge) opened up opportunities to establish a new start-up and seek further venture capital (see Section 5.2.3).

However, these grants were not enough to support the team and after three months I ran out of budget due primarily to maintaining salaries. As an Indie Designer/Developer, I knew that if I wanted to make the *Audio Game Hub* project a success I would have to commit my own savings (around 20,000 NZD).[159] I would also need to consider alternative sources of income.

5.2.2 Crowdfunding: Kickstarter campaign

Because the project ran out of money and individuals were forced to secure alternative employment, by October 2016 the project team consisted of only Jeong and me. Since the launch of *Audio Game Hub 1.0* we had received numerous international emails from blind gamers asking us to create more games. However, to do this I needed to expand our team and secure additional funding. I had become increasingly aware of other indie game development projects funded through crowdfunding platforms,[160] so I turned my attention to the potentials of a Kickstarter campaign.

Before beginning the initiative, I revisited the Game Development Meetup in Auckland and announced that we were looking for team members to help us expand the *Audio Game Hub* by running such a campaign. I explained that we were looking specifically for web developers, graphic designers and Unity 3D programmers who might like to work collaboratively on the project. Like the initial 2015 recruitment drive, the project attracted six new people.

---

[158] AUT Ventures is the commercialisation arm of Auckland University of Technology (see https://ventures.aut.ac.nz/).
[159] This investment was made a little easier due to me receiving a 90,000 NZD Vice Chancellor's Scholarship that paid my study fees and afforded me 2,000 NZD a month over three years. This invaluable support meant that I did not have to undertake parallel employment to pay for food and accommodation.
[160] For example, the *Blindside* audio game funded in 2013 (https://www.kickstarter.com/projects/600219258/blindside-the-audio-adventure-video-game). A full list of independent video game projects resourced through crowdfunding can be found at https://en.wikipedia.org/wiki/List_of_video_game_crowdfunding_projects.

As I had done previously, I explained our team culture, outlining the nature of an Indie project and explaining that we would share crowdfunding income proportionally across the number of hours each team member worked on the project. After the first week of work, we selected four developers who became the *Audio Game Hub 2.0* team. Because none of the team members had previous Kickstarter experience, I hired a crowdfunding strategist, Kat Jenkins.[161] She prepared a workshop for us[162] and explained how to run an effective crowdfunding campaign.[163]

To launch the campaign, we required a project webpage and an 'explainer' video. To save money, we took an indie approach and tried to create everything in-house (or by asking our friends and families for help). Juan Alejandro Rodriguez and David Delgado created an effective website[164] with an articulate project description and arresting graphics.

The explainer video was recorded free of charge by the university's camera crew (Jin Hong and Reza Mohammad Yari) and edited by my friend Luke Sniewski. The filming took several takes because we wanted it to look natural. Because we could not afford the high production values associated with professional directors and studio equipment, we employed humour and accessibility as key drivers of pitch. We wanted the 'explainer' to feel familiar and 'within reach'. However, to add an assurance about the quality of the initiative and the value of any investment, we interspersed our explanations with cut-aways of games we had created and testimonials from current users (see Video 5.1).

[161] https://www.linkedin.com/in/katjenkins/.
[162] The workshop cost was 800 NZD.
[163] The detailed workshop report containing the communication plan and campaign strategy can be found in Appendix C.
[164] https://www.kickstarter.com/projects/191576632/audio-game-hub-keep-your-ears-wide-open.

Video 5.1. The Kickstarter explainer video (please click on the image to play the sequence, or access this YouTube link).

We decided to launch the campaign during the Auckland Game Developers' Meetup, on the 8 November 2016 (see Figure 5.6). The team pitched the initiative collectively and participated in the official countdown. Within a few minutes of the launch we received support from several backers, including our friends and family.[165] This significantly increased the team's morale.

Figure 5.6. The *Audio Game Hub* team launching the Kickstarter campaign at the Game Development Meetup at Auckland University of Technology. From the left: Vincent Polehwidhi, Jarek Beksa, Juan Rodriguez, Jeong Su Jeon and David Delgado. © Jarosław Beksa.

[165] The father of one of our team members donated 1,700 NZD.

The intentions of the campaign were to:

- create five new games
- redesign the main menu
- add internal leader boards and an achievements system
- turn the *Audio Game Hub* into a paid initiative
- promote the project.

We created a list of 11 games that we were considering developing and asked our Kickstarter backers to choose five of these via a survey. We devoted the first two weeks of the campaign to marketing and PR; sending out press releases and information about the campaign to leading New Zealand magazines, gaming websites, YouTubers, and national and international blind foundations. After the second day of the campaign, the Kickstarter team awarded our project with the 'Project We Love' recognition (see Figure 4.7). We also received coverage on a number of New Zealand news websites and newspapers.[166]

Figure 5.7. 'Project We Love' ribbon granted by Kickstarter staff members. Retrieved from www.kickstarter.com.

A Kickstarter campaign normally runs for 30 days and on the seventh day we received encouraging news via an e-mail from Mark Barlet, founder of the AbleGamers Charity in the US. Our correspondence resulted in him pledging 4,000 NZD.[167]

As an adjunct to the promotion we also designed and produced a boxed version of the *Audio Game Hub* for higher-tier backers (see Figure 4.8). This was manufactured by a Polish company, Cursor S.A.

[166] For a complete list of media articles, see Appendix E.
[167] See Appendix D for correspondence.

Figure 5.8. The boxed version of the *Audio Game Hub* (left) and the USB Drive (right). © Jarosław Beksa.

The campaign ended on 8 December 2016, with a total of 11,052 NZD raised (minus the 5% Kickstarter fee) (see Figure 5.9). Our goal had been 6,000 NZD. We had been successful.

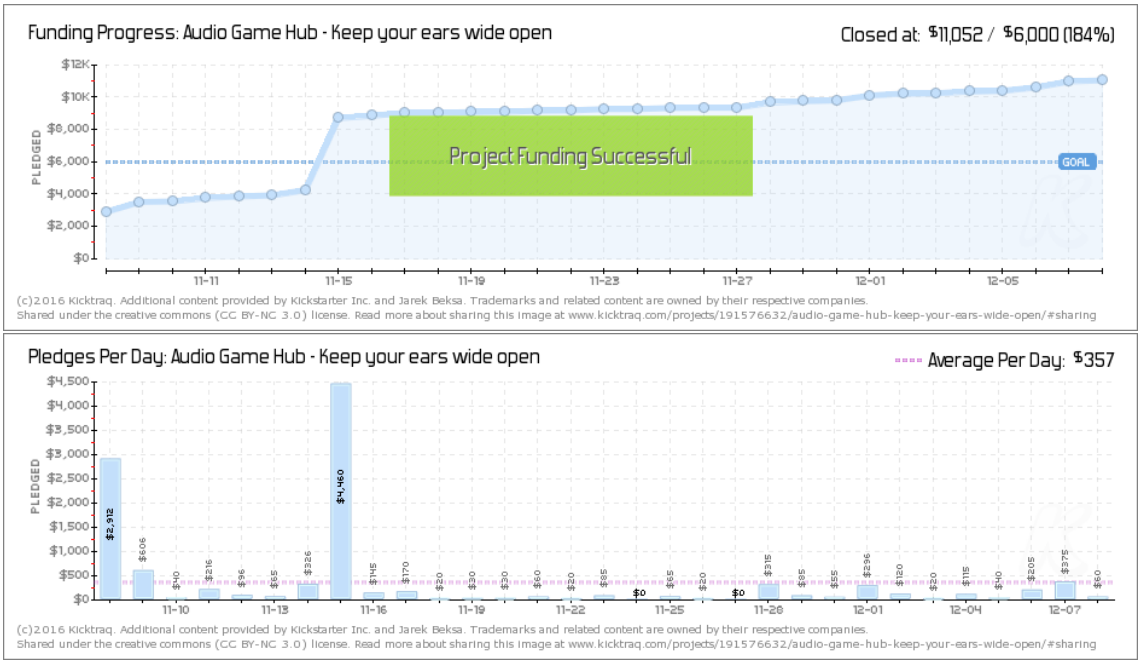


Figure 5.9. Kickstarter campaign funding progress (top) and pledges per day (bottom). Retrieved from www.kicktraq.com.

5.2.3 Engaging in parallel projects and employment

In addition to funding secured from academic research grants, private investments and crowdfunding initiatives, the project was also resourced by team members' strategic engagement with parallel projects. By this I am referring to the use of 'day jobs' so team

members were able to maintain sustainable incomes from other sources. Fitzmaurice (2019), in his discussion of 'day jobbing' as it relates to indie recording artists, observes: 'the truth is that most indie artists […] rely on multiple sources of income outside of their music career to pay the bills and put food on the table' (para. 2). The case studies he presents profile an almost ubiquitous behaviour where independent artists engage with alternative employment opportunities to temporarily resource financially unsustainable artistic pursuits. The attitude permeating Fitzmaurice's case studies is articulately expressed by Tamaryn Brown, a New Zealand indie songwriter and singer based in Los Angeles:

> There's this self-shaming perspective I've seen in a lot of my peers in that they feel like they're a failure of an artist if they have another job. I feel the opposite way about it. I think you're more of a failure if all you do is play in a band for the rest of your life, honestly. What a limited view of reality. I've found that the discipline and schedule of having a job only helps the creative phases of my life. It's like working out – it fuels your day and gives you more energy. (as quoted in Fitzmaurice, 2019, para. 5)

Putting Brown's comments about the potential for self-expansion through alternative work sources aside, what she and Fitzmaurice discuss is a picture that often runs counter to perceptions about indie artists. Notions of co-inhabited warehouse lofts or garages meeting the needs of shelter, income and cultural reinforcement constitute a largely romantic myth. The truth is that Indie Designers/Developers need money to generate outcomes. While a 'day job' may address rent and food, often it cannot be used to sustain the physical needs of the project itself. So while many team members in the *Audio Game Hub* had 'day jobs', in this project I strategically sought out parallel employment that might offer productive interfaces with the project. Here my aim was to use my skills to meet contracted clients' needs while providing income and resources that would enable the *Audio Game Hub* project to stay afloat. Wherever I could, I tried to negotiate the terms of engagement so the team might be afforded afterhours access to office space, the Internet, or networking opportunities.

Between 2015 and 2018, there were three parallel initiatives of note:

- the Lightning Lab Accelerator and Sonnar Interactive start-up projects
- a teaching assistant contract at Auckland University of Technology
- employment at Blind Low Vision NZ.

The first initiative involved me founding an independent company focused on the development of interactive audio stories.[168] This idea emerged after winning the AUTEL Innovation Challenge. One of the judges, Ross Peat, suggested that I apply for Lightning Lab Start-up Accelerator.[169] After a series of pitching sessions, Jeong, Alex Garkavenko and I entered the accelerator in March 2016 and established a new start-up called Sonnar Interactive Limited.[170] We received an initial 20,000 NZD investment, a 5,000 NZD 'Getting Started Grant' from Callaghan Innovation,[171] free office space, mentoring and access to New Zealand's venture capital network. This enabled us to fulfil our obligations on the contract with the accelerator and simultaneously access necessary support for the development of the *Audio Game Hub*.

The company enabled me to technically be a self-employed founder and director. Having a new company and completing the accelerator contract allows me to pursue further investments. Examples of this were the 25,000 NZD investment from AUT Ventures Limited and a 25,000 NZD grant from Vodafone Xone Accelerator.[172] As a company, we undertook application development projects for third parties (other companies). As a result, we ran multiple projects simultaneously. This enabled us to secure basic salaries and to work on the audio games in our spare time.

The second parallel initiative was a position I secured as a teaching assistant at Auckland University of Technology. This contract ran for just over 30 months and involved a commitment of 12 hours a week. While I found the engagement with advanced learning and teaching stimulating and I felt able to offer useful advice and support for student projects, the contract also afforded the *Audio Game Hub* free access to the office space at the Human Computer Interaction Lab and the university's IT infrastructure. While working on the contract, a number of students also became aware of the *Audio Game Hub* and one of them (Alex Garkavenko) joined the team.

The third parallel contract was with Blind Low Vision NZ[173] (formerly Blind Foundation). We established a good relationship with this organisation because we were involved with

[168] www.sonnar.nz/twisted-tales/.
[169] www.lightninglab.co.nz/programmes/digital-2016-auckland/.
[170] www.sonnar.nz.
[171] www.callaghaninnovation.govt.nz/grants/getting-started-grants.
[172] https://vodafonexone.nz/2017-xone-companies/.
[173] https://blindlowvision.org.nz/.

developing applications for people with visual impairments and we partnered with them in the development of the *Blind Cricket* game. This occurred at a time when Sonnar Interactive was struggling financially and all of the team members were seeking alternative full-time work to meet their living expenses. As a result, development on the *Audio Game Hub 2.0* games paused until our financial situations had improved. By this time, my PhD scholarship was also exhausted.

In our last week before taking up alternative employment, I pitched our previous work results and achievements to Sarvajith Ravishankar, the new Acting Chief Digital and Information Officer of Blind Low Vision NZ. He was impressed and offered our small team a contract to develop an Accessible Audiobook Player[174] available on Amazon Alexa Devices (smart speakers). We accepted the contract and cancelled our alternative work plans. Sarvajith generously offered us the opportunity to complete our remaining *Audio Game Hub* games during the working hours courtesy of Blind Low Vision.

5.3 Game refinement, development and publishing

5.3.1 Development and refinement of games in *Audio Game Hub 1.0*

When I began to work with the prototypes I had brought with me from Germany, it became clear that the prototype's code (developed at Gamification Lab) contained insufficient programmer's comments and that many parts of the application were hard-coded.[175] It quickly became evident that it would be faster to re-write the menu system and existing games completely. Within the next four months, our small team managed to re-create all of the games. I arranged new audio recordings for the user interface and menus (in English) at The Sound Room recording studio[176] in Auckland (at a cost of 1,400 NZD).

Audio Game Hub version 1.0 went live on Android and PC Windows on 15 April 2016 and seven days later on the iOS platform. In anticipation of the events, we had posted information about the public release of games on forums for blind gamers (AppleVis[177] and

[174] https://blindlowvision.org.nz/alexa-skill/.
[175] Hard-coding is a software development practice of writing data directly into the source code of a program, or fixed formatting of data in such a way that it cannot be altered without modifying the source code.
[176] https://thesoundroom.co.nz/.
[177] https://www.applevis.com/apps/ios/games/audio-game-hub.

Audiogames.net[178]). Almost immediately, the games began generating feedback from users through Apple Appstore and Google Play Store and were mentioned in forums (extracts from forum feedback can be found in Appendix D).

We quickly realised that people liked the games and would promptly report any errors ('bugs'). This was an exciting and stressful period because we cared deeply about the users' opinions and wanted to provide them with the highest quality entertainment we could design. We analysed users' reviews and tried to resolve issues as soon as they became apparent. Often, we had to work overtime (crunch[179]), including weekends and public holidays, to address flaws and then upload updates.

The updating process was relatively straightforward on the Android platform because we could immediately upload a revised version. On iOS, we had to pass the application review process[180] which was relatively long (up to 14 days). This often resulted in submission rejection due to small errors such as mistakes in application description, usage of double-tap gestures in the main menu or a missing link to Privacy Policy.[181] In total, the *Audio Game Hub* (up until the time I began writing this exegesis in 2018) was updated 20 times. *Blind Cricket* was updated 16 times (see Appendix F for a full list of updates).

5.3.2 Design and development of games in *Audio Game Hub 2.0* and *Blind Cricket*

Before the launch of the Kickstarter campaign, during one of the team meetings at Auckland University of Technology, we conducted a brainstorming session to collect the ideas for potential new games that might be included in *Audio Game Hub 2.0.* We listed 13 audio game ideas and, considering our budget, decided that we could afford to develop five. We could not decide which games should be implemented first, so I proposed to let our gamers and Kickstarter backers decide. We posted a list of game ideas on the project's website[182] with their descriptions and launched an online survey.[183] They survey remained

[178] https://forum.audiogames.net/topic/18679/audiogame-hub-for-ios-has-been-released/.
[179] In the indie game development industry, 'crunching' means working overtime as a result of fast-approaching deadlines on projects that do not have enough personnel assigned to them (Arguello, 2018).
[180] https://developer.apple.com/app-store/submissions/.
[181] Every game submitted to the Apple Appstore is required to provide a link to a Privacy Policy informing users about the data collected through the application.
[182] https://www.kickstarter.com/projects/191576632/audio-game-hub-keep-your-ears-wide-open.
[183] https://www.google.com/forms/about/.

open until the end of the campaign and only people who supported the project could vote. On 19 December 2016, the *Audio Game Hub* supporters had chosen:[184]

- Frogger (later called *Animal Escape*)
- Cricket
- Simon and Super Simon (later called *Bomb Disarmer* and *Super Simon*)
- Blackjack
- Runner.

The design and development of each of these games followed a similar pattern: ideation, prototyping and testing, publishing, feedback and refinement (see Section 4.4). Compared to *Audio Game Hub 1.0*, the biggest changes we made in version 2.0 were:

- developing new games
- designing a new menu and user interface
- implementing in-app purchases (paid games)
- enabling advertisements (for players who did not like to or could not afford to pay for games)
- implementing:
    - achievements
    - leader boards
    - a News section
    - cloud save
    - facilities for social media sharing
    - daily giftboxes
- creating an inverted graphics mode and a customisable font size.

Blind Cricket

Blind Cricket was the first of the five games developed after the Kickstarter campaign. Peter McGlashan,[185] External Relations Manager at Auckland University of Technology, was involved in coaching New Zealand's blind cricket team, the Black Caps. He introduced me to the players and the employees of Auckland's Blind Low Vision NZ. At the time, the Black Caps[186] were preparing for the blind cricket T20 World Championships (30 January

[184] https://www.kickstarter.com/projects/191576632/audio-game-hub-keep-your-ears-wide-open/posts/1767294.
[185] https://www.linkedin.com/in/peter-mcglashan-b2444b34/.
[186] http://www.nzbcainc.co.nz/.

2017)[187]. Peter suggested that the timing would be perfect for releasing a game of *Blind Cricket* and having it covered on national television.

Given this timeline, we had only one month to develop the initiative. The team agreed to another 'crunching' session and within three weeks, we had developed the main functionality of the game and the new menu system.

In the design/development process, I had to learn and understand blind cricket rules (Blind Cricket NSW Inc., n.d.). I also conducted field recordings of real blind cricket players playing the game (including rolling the ball from different angles as well as bat hits). To record live sound effects for the game, we used a Zoom H6[188] audio recorder with a wind protector.

To enhance the level of immersion, we tried to implement binaural sounds[189] using the 3D Ception Unity 3D plugin.[190] The results were satisfactory on the PC Windows platform, but we could not achieve the 3D audio effect on mobile devices. I was unable to establish whether this was due to the plugin or our incorrect implementation. As a result, we decided to retain the use of stereo sounds across all of the games and platforms.

To provide a sports-like game experience, I used ambient sound recordings from real-life sport events and selected appropriate background music.[191] We also had to re-record all the menus, instructions and tutorials with a new voice actors, including a cricket commentator. To minimise voice recording costs, I invited my friends Richard Durham and Peter McGlashan to the studio at Blind Low Vision NZ in Auckland and, courtesy of recording studio manager Phil Turner, we were able to perform the studio recordings free of charge (see Figure 5.10).

[187] https://www.crichq.com/organisations/679/matches/results.
[188] https://www.zoom-na.com/products/field-video-recording/field-recording/h6-handy-recorder.
[189] Binaural synthesis is a method that simulates a 3D audio experience via a pair of headphones using HRTF (Head Related Transfer Function) (Møller, 1992; Tsakostas et al., 2007).
[190] This plugin was discontinued in 2017.
[191] https://audiojungle.net/item/sport-music-pack/6843429.

Figure 5.10. Peter McGlashan and Richard Durham during a voice recording session at Blind Low Vision NZ in Auckland. © Jarosław Beksa.

Blind Cricket was our first game to use high-resolution 3D graphics, with models purchased from the Unity Assets Store. We also implemented new 2D graphics menu elements designed by Rafał Sadowski. The reason for the rich visual interface was to ensure that the game would also be attractive for sighted players, so sighted and non-sighted players could play together.

Due to the file size of the game, 3D graphics and new control options (accelerometer and gyroscope), I decided not to incorporate *Blind Cricket* into the *Audio Game Hub* but release it as a stand-alone application.

On 26 January 2017, Peter organised a showcase at Auckland University of Technology where our game was presented to the public (see Section 5.5.3). *Blind Cricket* was released on 3 February 2017 on Android and two weeks later on the iOS platform.

Bomb Disarmer

The second game chosen by the Kickstarter backers was *Bomb Disarmer*. It was inspired by the classic game *Simon* (Hasbro, 1978). I did not want to create a replica of *Simon*, where the player must repeat random sequences of sounds. Instead, I sought to enrich the game with a background story, high-quality sound effects and cinematic music.[192] I was seeking to replicate the atmosphere found in action movies. The audio recordings for this game

[192] https://audiojungle.net/.

were performed at The Sound Room recording studio in Auckland and Blind Low Vision NZ (at a cost of 700 NZD).

Super Simon

Some of the Kickstarter backers requested an 'exact' yet improved copy of the *Simon* game. We listened to their suggestion and created a game called *Super Simon.* To make the game more interesting and replayable, I prepared over 40 different sound packs that could be unlocked for free, either through daily gift boxes, by unlocking achievements or as a paid option via in-app purchases.

Blackjack

In designing this game we modified the rules of Blackjack (as it is played in casinos across the US) by using two decks of cards with no splits allowed (Shackleford, 2015). After about a week of testing, the computer's artificial intelligence (AI) was set to not hit above 17.
In conjunction with *Blackjack*, we introduced a sub menu, 'Casino Games' and internal currency. The virtual coins can be used in both *Blackjack* and *Slot Machine*. Players had an option to purchase one of the available coin packs or receive a small number of coins through daily giftboxes. Jeong was sceptical about the virtual currency, but to our surprise the coins worked well; in fact, they have become the second most popular purchase within *Audio Game Hub 2.0* (see Appendix E).

We spent the last month of development on implementing leader boards and achievements (also for games included in *Audio Game Hub 1.0*). This change required implementation of TTS functionality, which was necessary to read out usernames and their scores. We tested a number of available plugins for Unity and finally implemented RT-Voice Pro.[193] Using a synthetic voice also allowed news reading inside the game menu without recording new voices and updating the applications.[194]

After a series of testing and bug fixing, weeks of crunching and multiple rejections and re-submissions to App Store, we eventually released *Audio Game Hub 2.0* with three new games on 7 June 2017 on Android and on 13 June on iOS.

[193] https://www.crosstales.com/en/portfolio/rtvoice/.
[194] News was stored in a text format on an external web server.

Animal Escape

Over the next four months, we worked on the game *Animal Escape* in our spare time. This game was inspired by *Crossy Roads*, released by Hipster Whale in 2014, and included 3D graphics obtained from the Unity Assets Store. In this game, I incorporated real cars and train sounds, and the Doppler Effect[195] was used to simulate the sound of moving vehicles.

Voice recordings were performed by Joe Gilfillan at the Blind Low Vision NZ's recording studios, free of charge. *Audio Game Hub* version 2.2, including *Animal Escape*, was released on 7 May on Android and on 23 May on iOS.

A fifth game, *Runner*, was never implemented. However, it is a work in progress and I intend to complete this work before we create additional games.

5.4 Monetisation

After the initial release of the *Audio Game Hub*, many users wrote to us, saying that they would like to see more games (see Appendix D). I saw this as an opportunity to test the willingness of blind gamers to spend money on games. In addition, monetisation of *Audio Game Hub 2.0* was an attempt to make the project financially self-sustainable. As such, it became an investigation into the potential of revenue generation.

Several monetisation techniques were implemented in the form of in-app purchases (see Figure 5.11) and advertisements. These included:

- Non-consumable. These involved a one-time purchase that never expired. They included:
    - an all games bundle
    - each of the games separately (excluding *Blackjack* and *Slot Machine*)
    - sound packs
- Consumable. These were multiple purchases that included:
    - coin packs (optional, coins could be obtained for free in 1,000, 10,000 or 50,000 denominations)

[195] The Doppler effect is a frequency change of sound, light or other waves as the source of the observer moves towards or away in proximity (NASA, n.d.).

- donations (in USD; an act of donation would put a user on a co-producers' list in $5, $10, $50 or $100 denominations)[196].

- Subscriptions. These could be for one month, three months, six months or 12 months
- Advertisements.

Figure 5.11. In-app purchases screens. *Audio Game Hub 2.0* purchases screen (left) and *Blind Cricket* donation screen (right).

By implementing advertisements we were able to provide free access to people who could not afford the games.[197] The advertisements took the form of 15- or 30-second videos displayed before starting a new game and could be closed after initial viewing. Unfortunately, due to a lack of compatibility with Voice Over and Talk Back, users had issues finding the 'Close Ad' button, which was usually located in the upper-right corner of the screen (see Appendix D, review from RYAN HSU). This resulted in accidental advertisement activations and relatively high initial revenues[198] due to the high click-to-view ration. In other words, because the 'Close Ad' button was something generically designed to be 'seen', visually impaired gamers were accidently clicking on advertising in higher proportions than might normally be expected.

[196] 50% of donations in *Blind Cricket* game will be transferred to New Zealand blind cricket team Blind Caps.
[197] Many users from developing countries such as India and Pakistan requested a free-to-play option because often they could not afford to purchase the games at Western rates. According to the World Blind Union (2017), 90% of visually impaired people live in a low-income setting.
[198] We implemented Google AdMob as our main ads service provider.

I was aware that displaying video ads in a game for non-sighted users did not make much sense, but I anticipated that we might be able to draw revenue from advertisers rather than from users. This is called the freemium model (Kumar, 2014; Shmilovici, 2011). Under this model, a business provides a service at no cost to the consumer and revenues are generated through the display of advertisements.

A detailed summary of the most popular and effective monetisation methods employed in the project is presented in Appendix E.

5.5 Marketing and promotion

While there were multiple informal strategies employed in advancing the development and promotion of the games in this thesis, four specific initiatives warrant discussion:

- the *Audio Game Hub* website
- accessible games forums and websites
- general media, events, conferences and awards
- social media (Twitter, Facebook, YouTube, etc.).

5.5.1 Website

The *Audio Game Hub* website was located at www.audiogamehub.com (see Figure 4.12). Its purposes were to increase the chances of finding the games via search engines (e.g., Google) and provide information about the games and download links for the supported platforms. The site was created by Alex Garkavenko using WordPress[199] and the Atmosphere Pro theme.[200]

To ensure that the website was accessible to visually impaired people, we tested it with an online tool – AChecker[201]. We also implemented Google Analytics to collect information about website visitors and traffic. The website featured:

- a landing page, with a video trailer, download links and a contact form
- an 'About' page (that provided information about the development teams)

[199] https://wordpress.com.
[200] https://my.studiopress.com/themes/atmosphere/.
[201] https://achecker.ca/checker/index.php.

- a news page (that provided information about updates and events)
- a listing of high scores (featuring leader boards for individual games in *Audio Game Hub 1.0*)
- a forum (where users could exchange information)
- a press kit (containing information about the project and promotional materials such as logos, screenshots and team photographs).

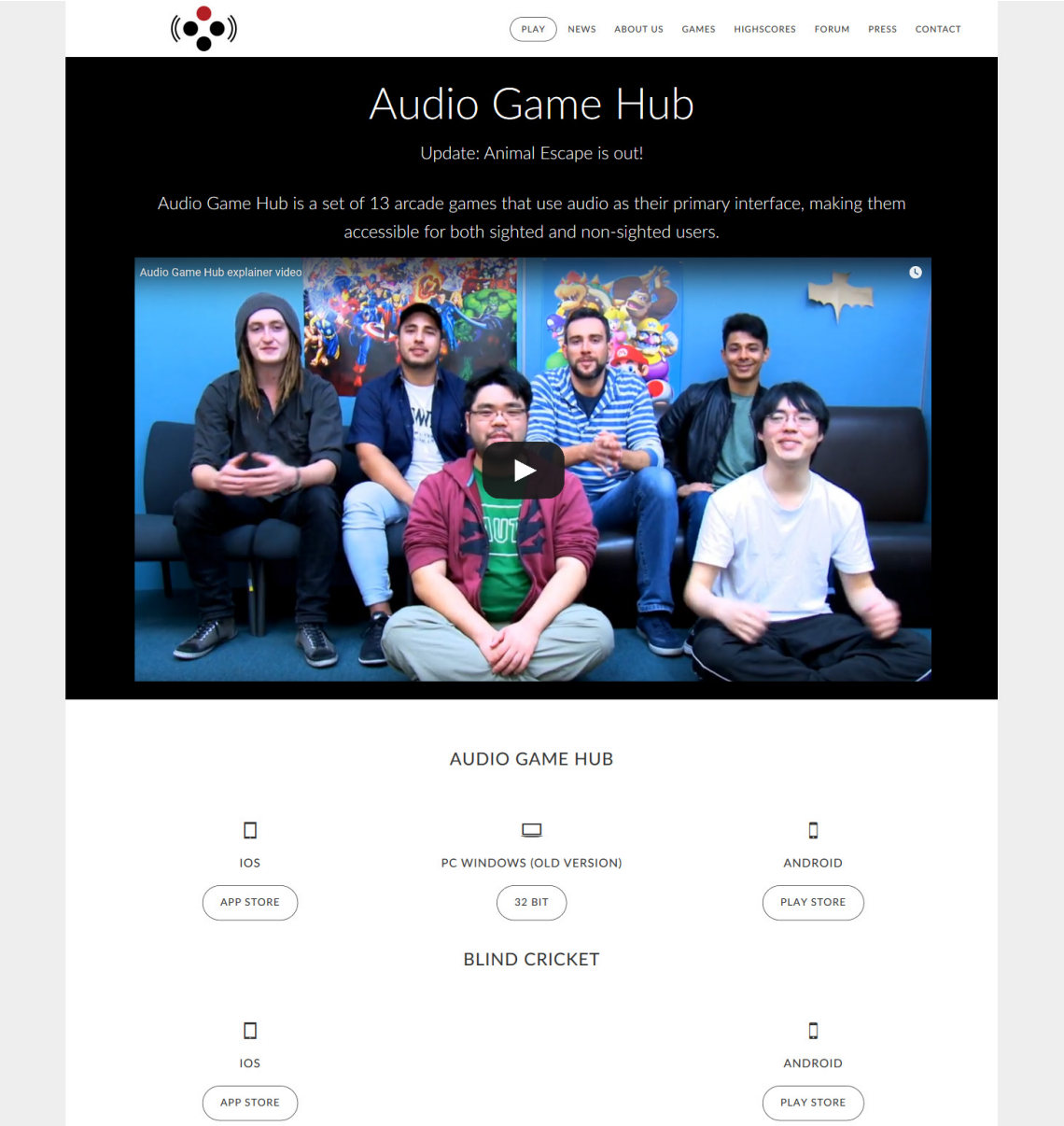


Figure 5.12. Audio Game Hub website screenshot. © Jarosław Beksa.

The forum was instigated in an effort to generate more traffic on the website and encourage discussions between users. The first version was built using the PunBB[202] plugin for WordPress (the same one used by Audiogames.net). However, the forum was outdated[203] and, therefore, vulnerable to attacks from hackers. After a few weeks, because of spam procedures,[204] we switched it off and installed another plugin, Mutt.[205] This alternative forum, although more secure, did not attract discussions between the users. A possible explanation for this may be users' accumulated frustration with previous edition of the forum.

Another method for increasing traffic was the addition of leader boards. The high scores section was implemented using the MySQL database[206] and it allowed users to submit their game results without the need to register an account. This was convenient for players, but it caused problems with the accumulation of multiple entries from the same users, for example:

- Mike Green – 10,300
- MikeGreen – 10,300.

This issue meant that we had to regularly 'clean up' the database and remove duplicates manually. Accordingly, we abandoned this high score system after releasing *Audio Game Hub 2.0.*

5.5.2 Accessible games forums and websites

Given the project's independent design and development, I was constantly investigating low-cost ways to promote our games and engage with users. We identified numerous popular places on the Internet specifically related to accessible gaming and posted information about the release of our games on them. Significant among these were forums like AppleVis[207] and Audiogames.net.[208] This was an effective way to promote the games and also enabled us to collect user feedback that we used to refine and update the *Audio Game Hub.*

[202] http://punbb.informer.com.
[203] Its last update was in 2015.
[204] In the first month, we had over 3,000 new registered users, some posting random comments containing links to commercial and porn sites.
[205] www.mutt.com.
[206] www.mysql.com.
[207] www.applevis.com.
[208] www.audiogames.net. This site had over 190,000 registered members.

5.5.3 Media, events, conferences and awards

As an Indie Designer/Developer, I had to rapidly learn how to find ways for the project to capture media attention. I also had to quickly overcome personal anxieties about public speaking.[209] This was important because independent projects like the *Audio Game Hub* are more likely to be sustained if they capture and maintain public attention. Without being 'present in the visible world' they cannot continue to attract the financial investment or networking opportunities necessary for their progress. Thus, as Dreskin (2015) notes, the marketing of independent design projects is normally an ongoing process rather than a post-development activity.

An example of marketing off a media engagement was an event organised a few days before the official release of *Blind Cricket*. Peter McGlashan had organised a showcase at Auckland University of Technology where the game was presented to the public. He invited the national blind cricket team (the Blind Caps) and reporters from TVNZ One (see Video 5.2). Although this event did not result in higher sales, it did help build our credibility and increased public awareness of the project.

Video 5.2. TVNZ One footage from the *Blind Cricket* showcase at Auckland University of Technology. This photo features Blind Caps team members playing the game (YouTube link). © Television New Zealand. Used with permission under Auckland University of Technology's screen rights' licence.

We also participated in Auckland University of Technology's student orientation day where we had a chance to showcase our games and play with sighted students (see Figure 4.13).

[209] A full list of media coverage, conferences and awards is presented in Appendix E.

This event introduced prospective students to a living example of independent game design/development. I wanted to do this because I was intent on promoting independent design and its intersection with design for social good. It appeared to me that students entering universities might be an emerging generation of thinkers who could consider the value of independent agency.

Figure 5.13. Jeong Su Jeon playing the game *Samurai Tournament* with sighted students during Auckland University of Technology's student orientation day (11 April 2016). © Jarosław Beksa.

I presented our project at national and international conferences such as the New Zealand Game Developers Conference in 2017 (see Video 5.3). This was a useful way to promote the team and project while contributing to the indie game development community by sharing information about our project's challenges and results.

Video 5.3. Jarosław Beksa presenting the Audio Game Hub project during NZGDC 2017 (YouTube link). © New Zealand Game Developers' Association. Used with permission.

I also promoted the project by submitting it to national and international competitions. A day after the release of *Audio Game Hub 1.0* on the Android platform,[210] we received the Excellence in Representation Award at the Play by Play Festival in Wellington. A year later, our project received the Highly Commended award at the NZ Innovation Awards (see Figure 5.14). Similar to the public profiling already discussed, these public acknowledgements lifted morale within the team, helped to promote our initiative and publicly reinforced the project's credibility.

Figure 5.14. Jarosław Beksa, Mitali Purohit and Jeon Su Jeon during the New Zealand Innovation Awards (19 October 2017). © Jarosław Beksa.

In addition to public acknowledgement that I pursued for the project, our games sometimes received awards without our involvement. On 25 April 2018, the *Audio Game Hub* was nominated for the Best Accessibility Experience award category in the 2018 Google Play Awards (see Figure 5.15).[211]

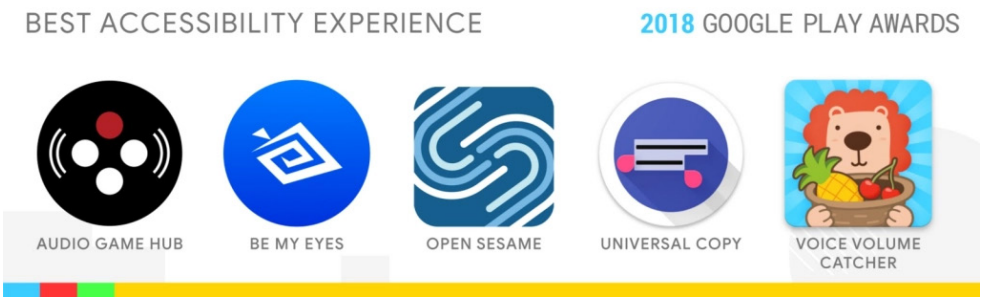


Figure 5.15. Google Play Awards 2018, Best Accessibility Experience nominees. From the left: Audio Game Hub, Be My Eyes, Open Sesame, Universal Copy and Voice Volume Catcher. © Google Play.

[210] On 16 April 2016.
[211] See Appendix D for correspondence.

Although we did not win the competition, our games were the first New Zealand application nominated for these awards. The recognition from Google resulted in significantly increased media publicity. An example of such media attention was an interview on Breakfast TV on TV One (see Video 4.3).

Video 5.3. Interview on Breakfast TV, TV One, after being nominated for the Google Play Awards (7 May 2018) (YouTube link). © TV1 New Zealand. Used with permission under Auckland University of Technology's screen rights' license.

Although events like these may appear on the surface to be the pursuit of celebrity, media attention is in fact a core contributor to project credibility and a catalyst for additional support. Because independent game design and development does not have a substantial corporate infrastructure behind it, one has to become extremely agile in the pursuit of alternative (and where possible, ongoing) methods of resourcing.

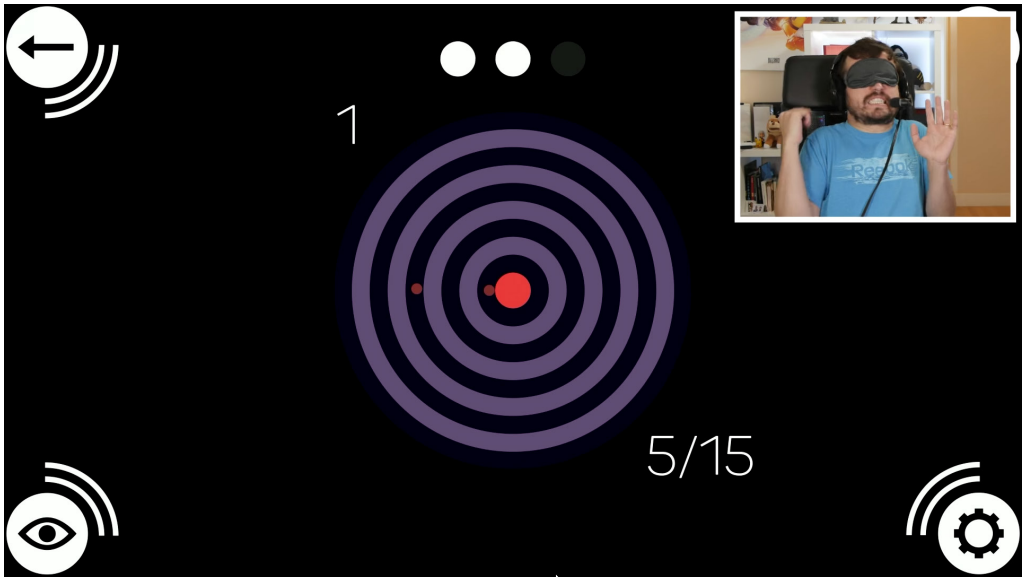
5.5.4 Social media

Given this position, I also considered the potentials of social media as a low-cost and effective way of marketing and promotion. Accordingly, we set up accounts on popular social media platforms like Facebook[212], Twitter[213] and YouTube.[214] While these were primarily concerned with marketing and promotion, they also enabled us to collect feedback from users.

As the project developed, I approached many journalists, game reviewers (both sighted and non-sighted) and influencers. Often our games were reviewed organically (without our

[212] https://www.facebook.com/audiogamehub/.
[213] https://twitter.com/audiogamehub?lang=en.
[214] https://www.youtube.com/channel/UCdfXmA3olZTUGvXRSZBxfwQ.

involvement).[215] Thanks to a popular YouTuber Coisa de Nerd (see Video 5.4), the *Audio Game Hub* received a significant boost in downloads and user reviews (his video critique of our games was viewed over 1.5 million times). A selection of YouTube videos with over 1,000 viewers is presented in Appendix E.



Video 5.4. Audio Game Hub video review by Coisa de Nerd (YouTube link). © Coisa de Nerd. Used with permission under Auckland University of Technology's screen rights' license.

Valentine (2019) described indie game developers/designers as 'generalists'. At the outset, my initial skills in game design were insufficient to undertake the complexity of what the project became. Accordingly, I was forced to extend my practices into team responsibility, leadership, media liaison, promotion and marketing. These things became part of an integrated and challenging dynamic of progress and survival. Like most independent artists, I did not have training in these fields; I had to draw on a belief in the inherent value of what was being created and develop an agile approach to storytelling, promotion and systems for eliciting productive feedback.

5.6 Summary

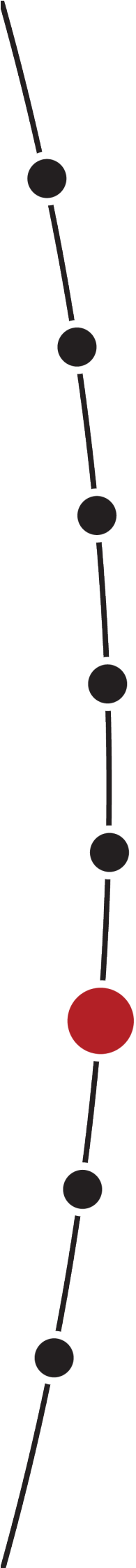
This chapter has briefly outlined how the nature of indie design/development impacted on the project's form and development. In shaping approaches to leadership and team

[215] Indeed, the search phrase 'audio game hub' on YouTube in 2018 returned over 1,000 results.

building, I adopted a comparatively decentred role that was predicated on nurturing a surrogate 'family' where values like *manaakitanga*, belonging, and high levels of perceived ownership and agency were supported by shared recognition and attribution.

Given the unstable nature of the project, I explored broad approaches to attracting and securing funding that, while offering temporary support, were also limited and had to be supplemented by sustained periods of personal investment and goodwill from parties involved in the project. This resulted in some collaborators falling away when funding became sparse and others advancing the project through high levels of tenacity and commitment. To heighten the chances of attracting funding, I sought out opportunities to profile and market the games we created. This involved securing academic research grants or private investment, crowdfunding, establishing a parallel business and supporting team members when they engaged in parallel projects and employment. In addition to these initiatives, I set up the *Audio Game Hub* website and promoted the initiative across games forums, special events, television and social media platforms. Finally, when *Audio Game Hub 2.0* was released in 2017, I implemented a range of monetisation techniques in the form of in-app purchases and advertisements.

Having discussed the project in relation to indie design/development, I will consider the games themselves as discrete but broadly groupable artefacts.



The games as artefacts

Tomek Tworek, the blind gamer who prompted me to undertake this study in 2006, observed that often audio games are simple adaptations of arcade video games and lack depth, diversity and sound quality. In this project, I tried to explore the richness of these missing elements by incorporating new game mechanics and adding story plots, gamification elements (such as leader boards and achievements) and a high-quality audio layer. In addition, all of the games contain one or more 'Easter eggs'.[216] The Easter eggs not only increase depth and replayability but also suggest that the game designers are enjoying the development process and, in some way, also playing inside the pleasures of game culture. Given these features, this section provides a catalogue of the games with brief descriptions and a discussion of how feedback became integral to the development of the work.

The games in the thesis may be divided into three categories:

- games in *Audio Game Hub 1.0* (these games had pre-existing prototypes that were subsequently developed in this project, then refined by employing user feedback loops)
- games in *Audio Game Hub 2.0* (these games were designed, developed and refined entirely within the thesis study and also employed user feedback loops)
- *Blind Cricket* (an independent game also generated in the study) (see Figure 6.1).

Figure 6.1. Overview of games developed in this thesis. © Jarosław Beksa.

[216] An Easter egg in video games refers to a hidden, undocumented game feature, surprise, pop culture reference or joke (ITR, 2019; Nolen, 2019).

This chapter is divided into five sections:

- a discussion of the user interface across all games in the project (including consideration of the generic output, input and games menu) (Section 6.1)
- a discussion of games and the agency of feedback in *Audio Game Hub 1.0* (Section 6.2)
- a discussion of games and the agency of feedback in *Audio Game Hub 2.0* (Section 6.3)
- a discussion of the game *Blind Cricket* (Section 6.4)
- a brief conclusory overview considering the implications of the discussions in preceding sections (Section 6.5)

6.1 The user interface of the games

The *Audio Game Hub* (1.0 and 2.0) and *Blind Cricket* required different types of interaction pattern and audio gameplay mechanics to standard video games because they use sound as their primary interface. The games were publicly released on iOS, Android and PC Windows platforms (see Video 6.1).

Video 6.1. Promotional video for the *Audio Game Hub* version 1.0 (YouTube link). © Jarosław Beksa.

6.1.1 Output

Audio

The games are self-voiced applications,[217] meaning they do not require screen readers[218] such as VoiceOver[219] or TalkBack[220] for people to play with them. During the study, we received mixed feedback from the users relating to the games being self-voiced. Some preferred our approach because it afforded better voice quality (a live actor rather than a synthetic voice) and faster responsiveness. Conversely, other users complained about the need to disable the accessibility mode on their devices before playing the games (see contrasting feedback in Appendix D, for example, the forum post from SLJ - 2017-07-13 and Google Play review from TallyChip).

Given the user demographic, the applications were heavily reliant on effective audio design (Collins, 2013; Friberg & Gärdenfors, 2004). Therefore, we paid particular attention to a range of sound features in the audio interface. Each user action was represented by a sound and the virtual 2D space of the games was created by utilising stereo panorama (x-axis) and pitch (y-axis). An array of background ambient sounds and various in-game character voices were employed to represent each of the game worlds and enhance a sense of immersion for the player. In some of the games (e.g., *Archery*, *Hunt*, *Slot Machine* and *Blind Cricket*), I tried to use real-world sound recordings (background ambience, foley[221] sound effects and voice recordings) related to the game's physical environment. The aim here was to increase a sense of realism in the experience. However, in games that took place in fantasy worlds (e.g., *Blocks* and *Simon*), I tended to embed synthetised, artificial sound effects.

In all of the games, the main menu screens are accompanied by relaxing background music, whereas specific game menus contain music designed to reflect the game's specific theme. Examples of this can be heard in the Japanese-style music used for *Samurai Tournament* and casino ambience designed for *Slot Machine*.

[217] An application that provides an aural interface without requiring a separate screen reader.
[218] VoiceOver (iOS) and TalkBack (Android) are operating systems-integrated screen readers that allow blind users to interact with the device.
[219] https://www.apple.com/nz/accessibility/iphone/vision/.
[220] https://support.google.com/accessibility/android/answer/6283677.
[221] Foley refers to the reproduction of everyday sound effects that are added to films, videos and other media in post-production.

Selected interactive sounds used in both the game menu and the individual games were assigned to specific actions and events (e.g., 'settings' and 'go back' buttons). Collin (2013) emphasises the importance of this 'repeatability' when designing for visually impaired gamers because such design features heighten the continuity of experience for players.

Graphic elements

The bold minimal, graphic interface used across the games corresponds with the input gestures used to interact with the game (see Section 6.1.2). All graphic icons are highly contrasted in response to recommendations published by Barlet and Spohn (2012), Game Accessibility Guidelines (n.d.) and IGDA GASIG (n.d.-c). The graphics interface also scales according to the device's screen size and resolution.[222]

The first prototype of the *Audio Game Hub* did not contain any visual elements and we noticed that sighted users struggled to play the games. Feedback suggested that this was because they felt lost without some form of visual interface. Including a graphic interface was useful in the development phases of the games because it provided information about the location of objects on the screen (e.g., moving animals in *Animal Hunt*). Having a graphic interface also made it easier when presenting the games at events and conferences and in the media.

Although these visual elements are not necessary for gameplay, my intention was that the games should be user-friendly and enjoyable for both sighted and non-sighted players. Design decisions relating to this idea were reinforced by user feedback, because visually impaired gamers often expressed satisfaction with being able to play the games with their sighted peers (e.g., see Appendix D, email from Riz – 27.04.2016 and Eric – 03.04.2018).

In designing these games, I was also seeking a way of giving sighted players an insight into the way that blind users interact with games. Accordingly, the visual interface can be disabled at any time. In fact, there is an embedded incentive in the games to enable 'blind mode' because this normally results in a doubling of the game score, thus enabling a 'blind' player to achieve a higher leader board position. This feature was implemented so blind users would not find themselves penalised for impaired vision. Broadly, my decisions when

[222] By this I mean the icons and other elements are not of a fixed size (e.g., 300 pixels), but are displayed as a percentage ratio of the width or height of the screen. This ensures that the element proportions are preserved regardless of differences in screen resolution.

designing these features were predicated on the idea that audio games should be for anyone who can hear, not only for those who are blind.

I re-designed the graphics interface in *Audio Game Hub* version 2.0. In these games the bottom corner buttons were removed and an adjustable font size was implemented to improve game accessibility for visually impaired users. Another accessibility feature was the institution of an 'inverted mode' that changes the font and background colour as shown in Figure 6.2. This feature was implemented based on feedback from gaming accessibility expert Ian Hamilton who reviewed our games and proposed certain changes (such as adjustable text size and a high contrast mode) also emphasised that there is considerable diversity in visual impairment and some people prefer to read a black font over a white background and others the inverse. By providing this option, we improved the games' accessibility rating[223] and catered for a wider audience.

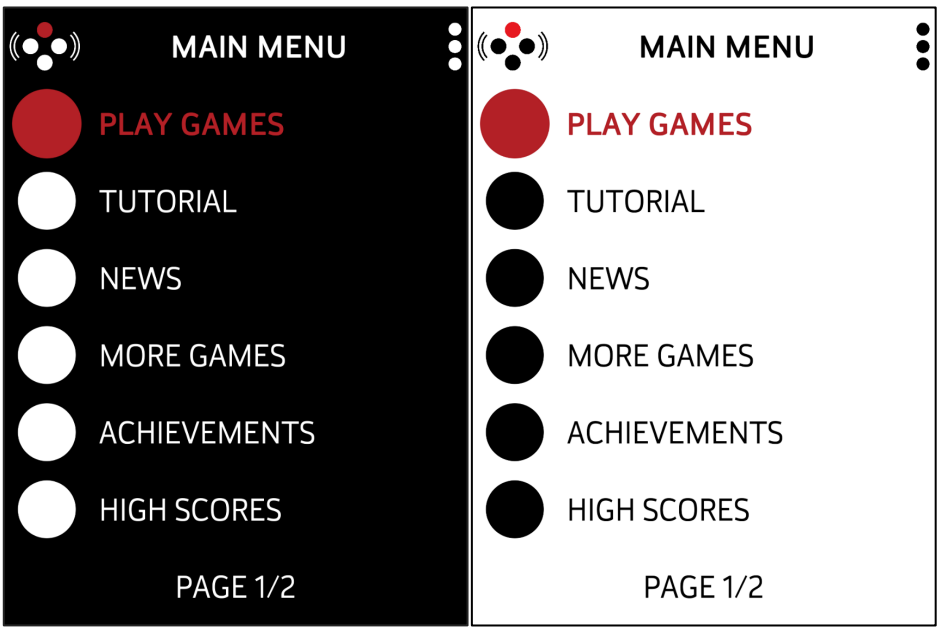


Figure 6.2. Audio Game Hub 2.0 graphics interface showing the main menu screen in 'normal' (left) and 'inverted' (right) modes. © Jarosław Beksa.

Haptic feedback

Based on Rosenberg and Brave's (1996) recommendations, whenever possible, we implemented haptic feedback (device vibrations) into the games to increase players' levels of immersion. For example, actions such as hitting a target with an arrow or pulling a lever

[223] http://game-accessibility.com/game/audio-gamehub/.

will activate vibrations on devices with such capability. Unfortunately, the Unity 3D engine did not allow us to control the frequency or length of the vibration.[224] In general, users reacted positively to this feature and our decision was supported by Tomasz Tworek, the legally blind, professional game tester, sound engineer and gaming accessibility advocate who mentored the project.

6.1.2 Input

The gesture-based input (touch screen devices) and mouse or keyboard input (desktop computers) for the games were designed using simple actions so players could easily navigate menus and interact with game mechanics. Controls in the games are limited to up, down, left, right, single and double taps or mouse clicks, and can be performed across most of the screen (excluding the corner buttons). This avoids the need for precision that often accompanies visually based games.

A single tap on the screen or a click enables a user to orient themselves, and the action triggers an announcement of the current element in focus. Hovering over the buttons 'reads' their name aloud. Menu elements can be navigated by a swipe gesture. User interface elements (options in the main menu or the corner buttons) are activated with a double-tap gesture (on touchscreen devices) and double-click or enter key (on a desktop).

A number of functions were necessary to navigate through the game menus. These functions were implemented in the form of buttons placed in the corners of the screen (see Figure 6.3). Having the buttons positioned as far from the centre of the screen as possible leaves more room for in-game and main menu gestures. The four 'corner buttons' in *Audio Game Hub 1.0* are:

- Upper left, Return: this takes you back to the previous menu
- Upper right, Information: here you can access audio information about your current position in game or an audio tutorial that explains the rules of the game
- Lower left, Graphics Mode: this enables you to switch the visual interface on or off
- Lower right, Settings: this enables you to adjust voice, sound effects and music volume levels.

[224] The strength and duration of the vibration cannot be configured. Unity 3D only allows a one-second block of vibration per function call.

Figure 6.3. Audio Game Hub 1.0 games menu screen showing the corner buttons. © Jarosław Beksa.

Some users reported issues with finding the active space[225] on touchscreen devices (e.g., see Appendix D, forum post from Sebby - 2017-07-17 and music fairy on 24 April, 2016). This is because certain devices have a non-responsive border on the touch-sensitive glass surface and this was resulting in accidental touches when holding the device. To address this issue, a calibration step in the tutorial was implemented. This allowed users to familiarise themselves with the physical size of their active touchscreen area. As a result of feedback, subtle audio cues (low frequency sounds) were incorporated into all of the games and these informed a user when they reached a corner button or the edge of their screen.

In *Audio Game Hub* version 2.0, the bottom corner buttons were removed and replaced with a new set of gestures (see Figure 6.4).[226]

[225] Tablet and smartphone touch screen glass surfaces contain a non-active area that allows one to hold the device without accidental interaction with the active area.
[226] These corresponded with the new menu structure discussed in Section 6.1.3.

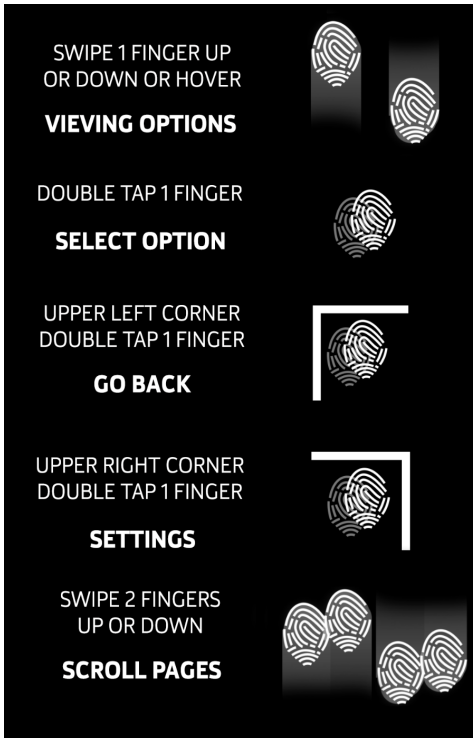


Figure 6.4. Audio Game Hub 2.0 Instructions Screen showing possible gestures in the user interface. © Jarosław Beksa.

6.1.3 Main menu

To guide new users and familiarise them with the interface, a general non-skippable tutorial is played on the first launch of the application.[227] The tutorial explains the basics of the user interface including navigating menu options, selecting options and using corner buttons (see Audio 6.1). In addition, when one begins a specific game for the first time, a tutorial explaining the game mechanics and game rules plays. We noted that the provision of a tutorial significantly reduced user comments asking for explanations about how to use the games.

Audio 6.1. Audio Game Hub 1.0 tutorial (link) (please use headphones for the best sound experience). © Jarosław Beksa.

[227] At the start of the application is a large circular button displaying the words 'Touch me'. This allowed us to distinguish between sighted and non-sighted users in application analytics (for more information see Appendix E: User demographics).

In *Audio Game Hub 1.0*, a user can navigate the menu options by swiping left or right on the screen (when using smartphones or tablets) or by dragging the mouse left or right, or by using the left or right arrow keys (when playing on a desktop) (see Figure 6.5 and Audio 6.1). The options within each menu are placed equidistant in the stereo panorama, giving the user an understanding of how many options there are in total. For example, the first element on the list will be played in the left ear and the last element in the right. To facilitate user orientation, the current menu position is announced whenever a new element or menu is shifted into focus and it can also be re-prompted by tapping or clicking on the screen the once. Menu element lists are not looped, and their ends are indicated by a specific sound cue.

Figure 6.5. Audio Game Hub 1.0 (left) *and Audio Game Hub 2.0* (right) main menu screens. © Jarosław Beksa.

For *Audio Game Hub 2.0*, the menu system was completely redesigned and changed from a horizontal to a vertical list (see Figure 6.5 and Audio 6.3). This list was divided into pages, depending on the number of available menu elements, and each page is announced with voice prompt. There were two reasons for this change:

- the horizonal menus in *Audio Game Hub 1.0* required a user to swipe left or right to check the available menu options. Feedback showed that this caused problems for sighted users who were familiar with dragging elements to change their position. Effectively, they were swiping right to move the element to the left, which felt counter intuitive when looking at the screen,

- having included leader boards, achievements, news and an increasing number of games meant there were more than 50 options on the menu (including the achievements menu). It is inefficient to expect users to swipe 50 times to find a particular element.

Audio 6.2. *Audio Game Hub 2.0* tutorial (link). © Jarosław Beksa.

Navigating through the menu option can be performed by either swiping up and down or hovering one's finger over the screen. Elements on the list are indicated with pitched audio cues, with the top element having the highest pitch and the last element (at the bottom) the lowest (see Audio 6.3). This approach also allows users to orientate their position in the menu and provides information about the number of available options.

Audio 6.3. A sample recording illustrating the navigation of menu elements using sound cues in *Audio Game Hub 2.0* menu (link). © Jarosław Beksa.

In addition, when a user enters any menu in the *Audio Game Hub 2.0*, they will hear a series of short 'tick' sounds, representing a number of available menu options on that page. This solution was implemented to inform the users of how many menu options are available to explore on each screen. Where the number of menu options exceeds one page, they are split into separate pages (and the page number is read to the user). To switch between pages, one can swipe up or down using two fingers. Menus in the *Audio Game Hub* and *Blind Cricket* are explored in a folder (tree) structure, and each menu is subdivided into sub-menus as presented in Figure 6.6.

Figure 6.6. Main menu structure diagram for *Audio Game Hub 2.0*. © Jarosław Beksa.

Achievements[228] and leader boards were implemented[229] because they proved to be an effective way of increasing replayability and player engagement (Griffin, 2014; Madigan, 2016). We received considerable feedback from users telling us about their attempts to become the best player and attempting to collect all of the achievements (e.g., see Appendix D, SLJ - 2017-07-13, Sneak - 2016-04-25). Each game has a separate leader board and separate set of achievements (see Figure 6.7).

[228] Achievement is a form of award for performing specific actions in games (e.g., completing the game within a specified time frame).
[229] We used Google Play Games (Google LLC, n.d.) and Apple's Game Center (Apple Inc., n.d.).

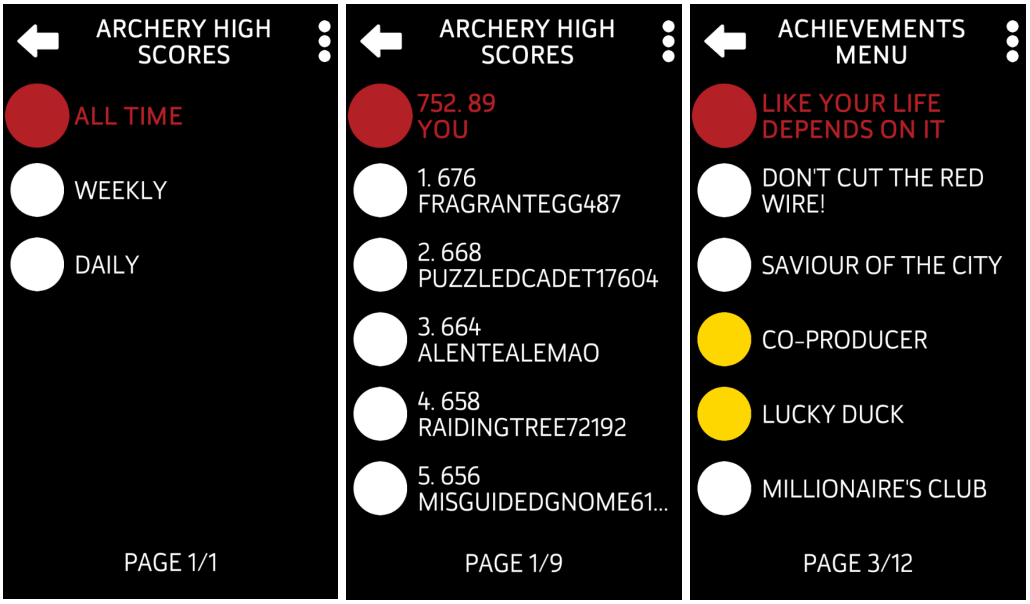


Figure 6.7. Leader boards and achievements screens in *Audio Game Hub 2.0*. © Jarosław Beksa.

Another feature I implemented to encourage players to replay our games was the provision of daily giftboxes. This idea was inspired by the video game *Sky Force Reloaded* (Infinite Dreams, 2014). Here, the designers offered users three boxes, each containing a random amount of virtual currency. In our games, in addition to the random coin count (spendable in the *Casino* games), we offered sound packs for the S*uper Simon* game.

Another addition to *Audio Game Hub 2.0* was a News section that allowed us to communicate updates and announcements to the players inside the games. The news was read by a synthetic voice (TTS) and we were able to add or modify content without having to update the whole application.[230]

The final feature was a More Games section which was an attempt to cross-promote our games. For example, in *Audio Game Hub 2.0* there was a link to the game *Blind Cricket* and vice versa.

[230] News is stored on a web server in plain text form.

6.2 *Audio Game Hub* 1.0

The games included in *Audio Game Hub 1.0* had pre-existing prototypes I had codesigned in Germany and were subsequently developed and refined inside the project. This was achieved by posting the games online then responding with updates (changes) based on user feedback. The feedback contained useful suggestions on improvements, but also reported bugs and issues experienced while playing the games (e.g., see Appendix D, Nathaniel Door, Aaron (Administrator) - 2016-04-24, Dark - 2017-07-14).

6.2.1 *Archery*

> *Welcome to the Archery Tournament of Sherwood Forest. You will compete against many splendid archers from the entirety of Nottinghamshire. If you prove to be the best, Lady Marion's hand will be yours.*

Audio 6.4. Archery tutorial and gameplay sample (link). © Jarosław Beksa.

In *Archery*, the player becomes a medieval archer and his task is to attain Lady Marion's hand by winning an archery tournament. To pursue this goal, the player has to swipe down and hold to draw a bow and release the arrow at the right moment. The aim sound travels from the left ear to the right in stereo panorama. To score 10 points, the player has to release the arrow when they hear that the aim sound is exactly in the middle (see Figure 6.8). If the player keeps their bow drawn for too long, the aim sound will begin to travel up and down (in lower and higher pitches respectively). This is a sonic metaphor for trembling hands. The tournament is divided into rounds, where each subsequent round requires more points to be scored. As one advances through each round, the aim sound travels more quickly.

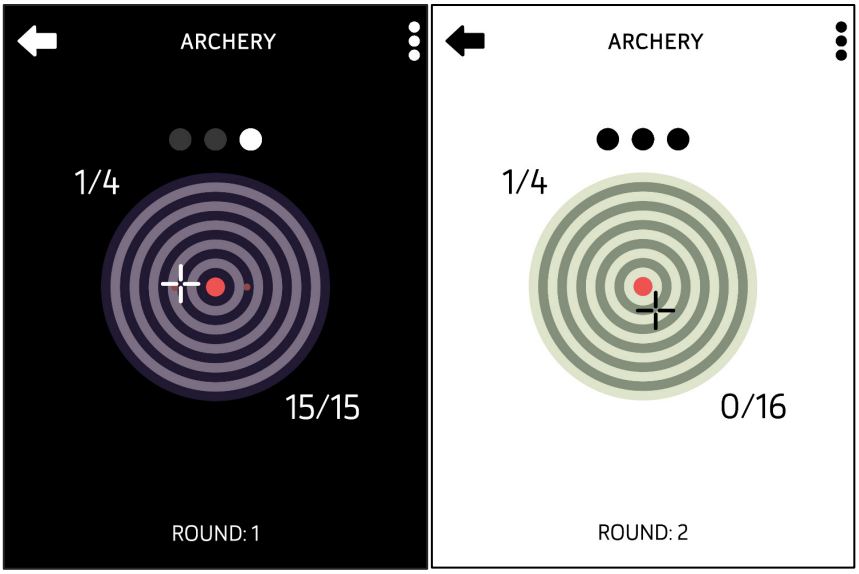


Figure 6.8. *Archery* game screens. © Jarosław Beksa.

The *Archery* game was influenced by the audio game *Cosmic Darts* developed by Klango in 2005, but it was also inspired by an obscure 1950s British Pathé news clip *Shooting by sound at St. Dunstan's, Sussex* (see Video 5.2). In this brief historical documentary, visually impaired men listen to high pitched sound through earphones. Using this data, they are able to assess if their rifle is on target. At the end of the sequence, a man with visual impairment feels the indentations made on the target as he assesses the effectiveness of his shoot.

Video 6.2. Shooting by sound at St. Dunstan's, Sussex (YouTube link). © British Pathé. Used with permission under the provisions of Auckland University of Technology's screen rights' licence.

In *Archery*, high scores are calculated based on the total score achieved in all rounds. When playing in Blind Mode (with no graphics) the final score is doubled. We added a score multiplayer in this mode to equalise the chances of getting the highest score and to encourage sighted players to try the games from a blind gamer's perspective. There are also achievements to unlock (see Table 6.1).

Table 6.1.
List of available achievements and their descriptions in the Archery game

Achievement name	Description
My Hero!	Saved Lady Marion
One with the Arrow	Won the tournament in Blind mode
The Force is Strong with this One	Hit 10 points 3 times in a row
Dart Padawan	Complete one level with minimum points required
Dart Vader	Complete the tournament with minimum points required

6.2.2 *Hunt*

> *Sherwood Forest is filled with animals of all kinds! We have to keep our jolly bowmen's stomachs full to withstand the sheriff of Nottinghamshire. You will hunt different kinds of animals like wild boars, foxes, rabbits and martens. The smaller and faster the animal, the more difficult it will be to hunt for it.*

Audio 6.5. *Hunt* game tutorial and gameplay sample (link). © Jarosław Beksa.

Hunt is a shooting game in which the user is tasked with hitting moving targets (forest animals). As the level of difficulty increases, the targets become smaller and move more quickly. The game ends when the player shoots all of the animals.

The aiming system in *Hunt* (see Figure 6.9) is based on a 2D soundscape represented by stereo panorama (the X axis) and pitch (the Y axis). There are two sound sources placed within the 2D game world and available to the player:

- The target, an animal (A)
- The aiming point (B).

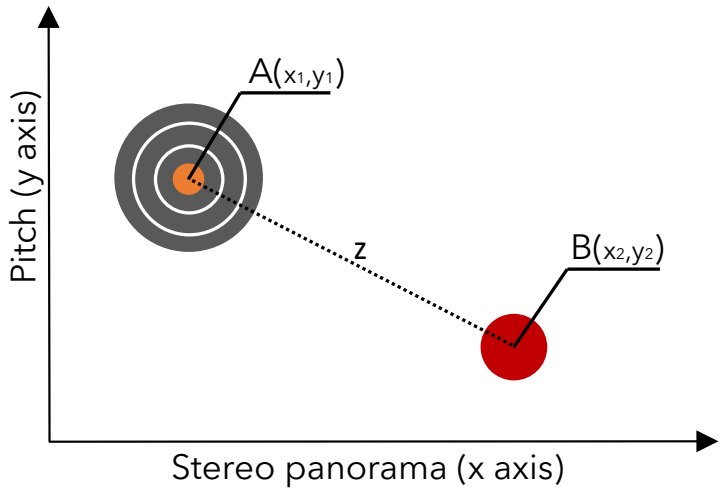


Figure 6.9. Aiming mechanics in the game *Hunt*. © Jarosław Beksa.

In each round, the animal sound (A) travels across the screen randomly. The aiming point sound (B) corresponds to the finger position of the player. When the finger moves closer to the target, the corresponding aiming point sound is played more frequently (Z indicates the distance between the target and the aiming point).

As described in Section 4.4, the ideation and development of the game mechanics was first drawn on paper then converted into digital form. The design then progressed through a series of prototypes where the aiming mechanics were tested and refined until satisfactory results were achieved. To do this, I adopted a form of embodied experience where I regularly blindfolded myself as I 'listened' my way through iterative experiments and refinements (see Figure 6.10).

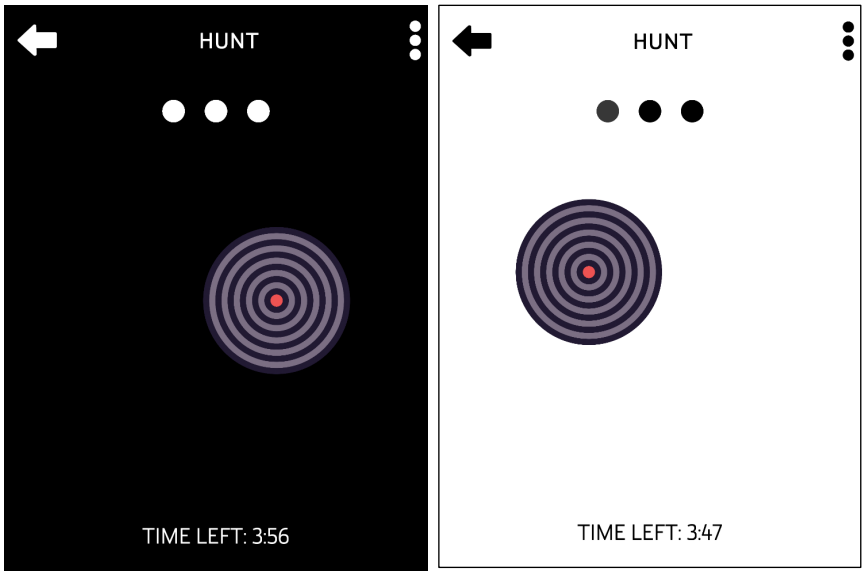


Figure 6.10. Hunt game screens showing a moving target. © Jarosław Beksa.

High scores are calculated based on the time taken to shoot each animal (the faster the time, the higher the score). As with *Archery*, when played in Blind Mode (with no graphics) the player's score is doubled. There are also achievements to unlock (see Table 6.2).

Table 6.2.
List of available achievements and their descriptions in the game Hunt

Achievement name	Description
Nothing left to prove	Completed the game
One Shot One Kill	Hit all animals with first shot
I'm not even looking	Completed game in blind mode
Empty the Forest	Hunted 100 animals
Vegetarian	Let an animal go

6.2.3 *Memory (Animal Farm)*

> *Hi there Newbie, welcome to my animal farm. We have just received a new shipment of animals in boxes. Your job is to find the animals of the same type and pair them up.*

Audio 6.6. Memory game tutorial and gameplay sample (link). © Jarosław Beksa.

Animal Farm is a digital audio adaptation of the analogue card party game *Memory*, also known as *Match*, *Pairs* or *Concentration* (Schumann-Hengsteler, 1996). The player's task is to find matching pairs of farm animals stored in boxes (see Figure 6.11). To locate the boxes, the player moves their finger around the screen (searching for a wooden box sound). Boxes are placed on a 2D plane where the stereo panorama represents the X axis and the pitch represents the Y axis. Each box is opened via a double-tap gesture that triggers the sound of the selected animal. Matched pairs of animals are removed until there are no boxes left and the puzzle is solved. The higher the level of difficulty, the more animals there are to pair up and the smaller the boxes become.

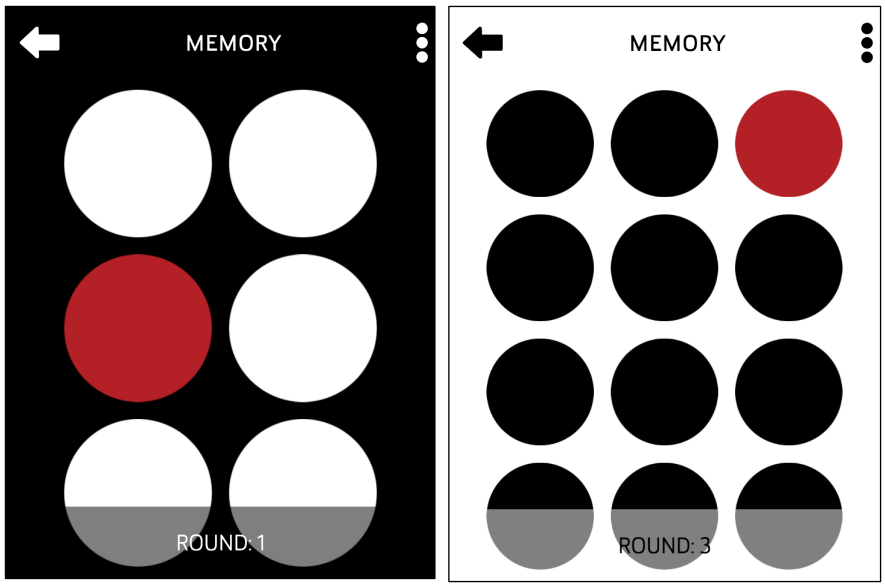


Figure 6.11. Memory game screens. © Jarosław Beksa.

The game mechanics were inspired by the audio game *Pirate Memory* (Klango, 2005), which used a stereo panorama for representing the X axis and volume for the Y axis. The

game's high scores are calculated based on the time taken to find matching pairs of animals and the number of attempts it takes to match them. As with the preceding games, when played in Blind Mode (with no graphics) the score is doubled. There are also achievements to unlock (see Table 6.3).

Table 6.3.
List of available achievements and their descriptions in the game Memory

Achievement name	Description
Memory Master	Completed the game
All in the touch	Completed game in Blind Mode
Must have cheated	Completed last round in less than 24 tries
The cow goes Moo	Complete 1st round in 6 tries
Petting Zoo	Find 100 animals

6.2.4 *Samurai Tournament*

> *Welcome to the Samurai tournament. You will fight against the finest warriors. If you defeat them all, you will come into the possession of the No-Dashi Blade, the fastest of all the Samurai swords.*

Audio 6.7. *Samurai Tournament* tutorial and gameplay sample (link). © Jarosław Beksa.

Samurai Tournament is a reflex-based game that allows gameplay for up to four players on one device. The screen is divided into four equal parts corresponding to the game space occupied by each of the players (see Figures 6.12 and 6.14). The goal is to beat other opponents by touching the screen quicker than the other players once one hears the 'trigger sound'. *Samurai Tournament* also supports one- and two-player modes. In single-player mode, the player fights against computer opponents. As the player progresses, the AI opponents' reaction times increase, making the game more difficult.

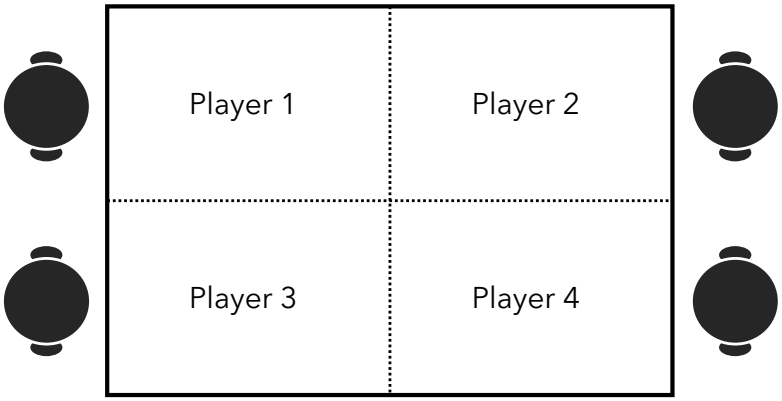


Figure 6.12. Layout of the four-player game *Samurai Tournament*. © Jarosław Beksa.

This game and *Samurai Dojo* constituted the first attempt to invite more players to the gaming experience without needing to be connected to the Internet. Collected user feedback had indicated that the ability to play the game with friends and family on one device can be more fun and creates an environment for building stronger interpersonal connections (e.g., see Appendix D, email from Eric – 03.04.2018). Accordingly, *Samurai Tournament* and *Samurai Dojo* constituted attempts to push the design features towards opportunities where people who are visually impaired are able to play with their sighted peers (see Figure 6.13).

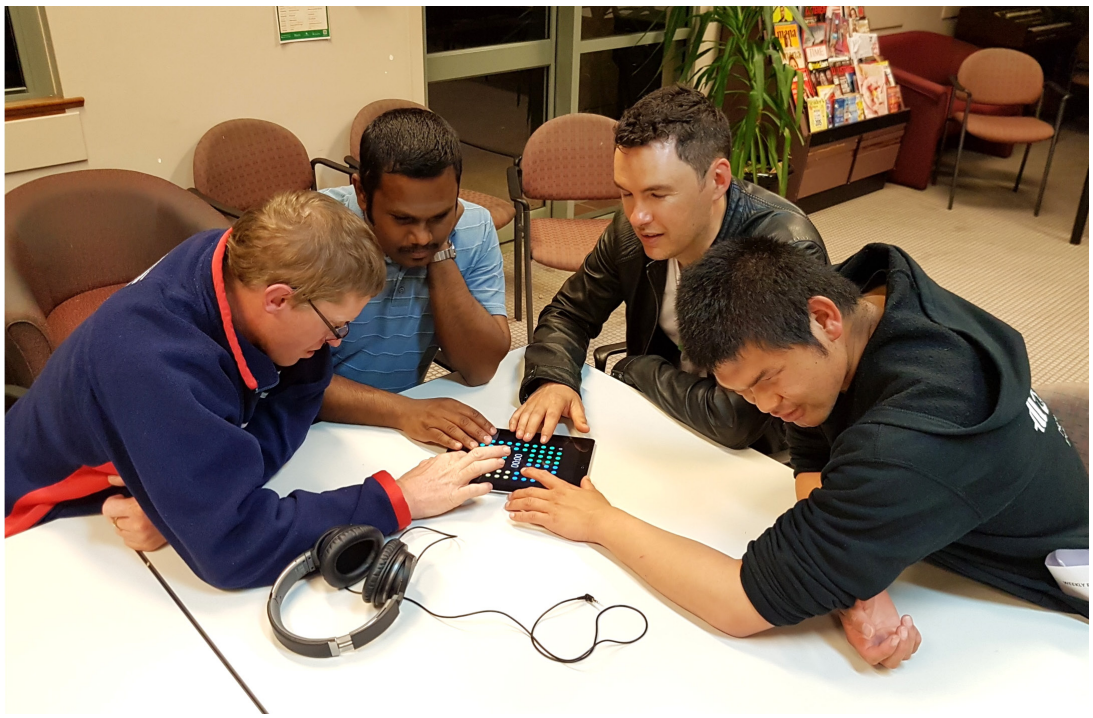


Figure 6.13. Three visually impaired and one sighted user playing *Samurai Tournament* (February 2017). © Jarosław Beksa.

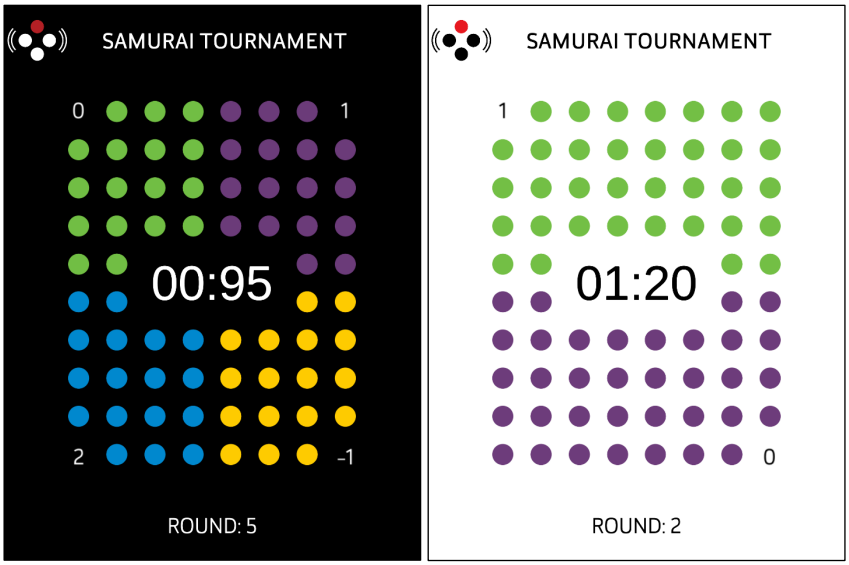


Figure 6.14. Samurai Tournament four-player game screens. © Jarosław Beksa.

High scores are calculated based on the time and number of attempts taken to defeat each of the opponents. When playing in Blind Mode (with no graphics), the final score is doubled. There are also achievements to unlock (see Table 6.4).

Table 6.4.
List of available achievements and their descriptions in the game Samurai Tournament

Achievement name	Description
Joe Esposito	Obtain the Nodachi sword
You're the best around	Completed game in Blind mode
Speedy Gonzalez!	Had reaction time less than 0.2 seconds
The Flash!	Had reaction time less than 0.1 seconds
Must have been beginner's luck	Won the tournament without losing a round

6.2.5 *Samurai Dojo*

Samurai, welcome to the Samurai endurance challenge. You will fight against each other to prove your endurance skills.

Audio 6.8. Samurai Dojo tutorial and gameplay sample (link). © Jarosław Beksa.

Samurai Dojo is similar to *Samurai Tournament*, with the difference being that instead of making the fastest one-touch, the players compete with the number of times they can tap the screen within a specified timeframe. The game also supports four-, two- and single-player mode.

The high scores are calculated based on the number of hits taken to defeat each opponent. Again, when playing in Blind Mode (with no graphics) the final score is doubled. There are also achievements to unlock (see Table 6.5).

Table 6.5.
List of available achievements and their descriptions in the game Samurai Dojo

Achievement name	Description
Three feet of fury	Completed the game
Blind master	Completed game in Blind mode
Three-hundred hand slap	Had more than 300 hits in one round
Precision over power	Won the dojo with exact number of swings

6.2.6 *Labyrinth*

Welcome to my labyrinth. In order to survive, find your way out.

Audio 6.9. Labyrinth tutorial and gameplay sample (link). © Jarosław Beksa.

In *Labyrinth*, the player's goal is to find the exit from Dracula's castle by following a 'guiding' sound. The closer the player gets to the exit, the louder the guiding sound becomes. The labyrinth consists of dark chambers and the player can move from one to another by swiping their finger up, right, down or left on the screen (see Figure 6.15). When double tapping on the middle of the screen, a voice reads out which passages are open. The labyrinths are generated randomly, so in theory each new game is different. When reaching higher levels of difficulty, the labyrinths become more extensive and complex.

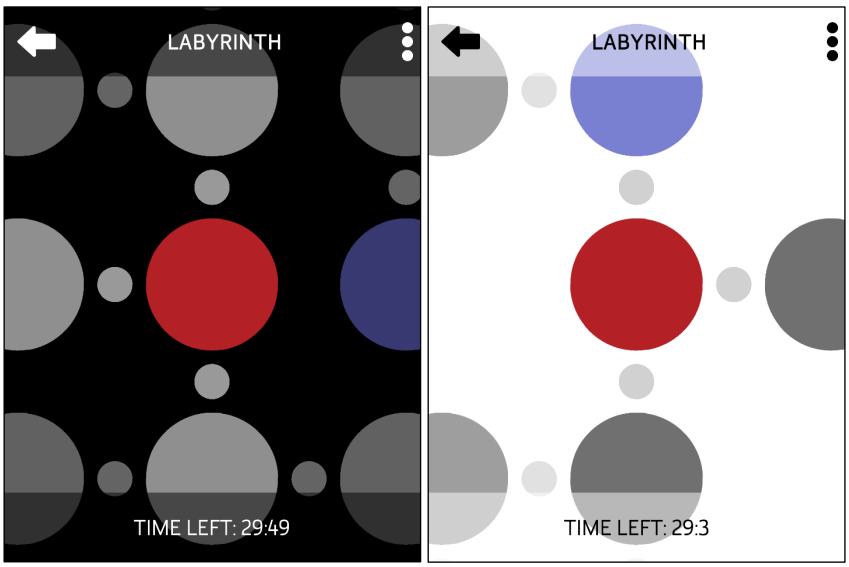


Figure 6.15. Labyrinth game screens. © Jarosław Beksa.

The high scores are calculated based on the time taken to exit all of the labyrinths. When playing in Blind Mode (with no graphics) the final score is doubled. There are also achievements to unlock (see Table 6.6).

Table 6.6.
List of available achievements and their descriptions in the game Labyrinth

Name	Description
Better than the Minotaur	Completed the game
Where are my keys?	Completed game in Blind mode
Master of Escape	Completed game in less than 15 minutes
The Castle of Aaargh!	Find the monster
WhoDunIt?	Find the dead body

6.2.7 *Blocks*

> *Your task is to sort the boxes and arrange them in rows of three or more of the same kind. Each box has a different barcode sound and they will move towards you on the line. The tray is divided into four sections and there are five types of boxes, so you must place them wisely.*

Audio 6.10. *Blocks* tutorial and gameplay sample (link). © Jarosław Beksa.

Blocks is an adaptation of the classic arcade video game *Bejeweled* (PopCap Games, 2001). This was inspired by the audio game *Haunted Factory*, released by Klango in 2006. The player's task is to sort moving boxes into groups of three or more. Each box has a different 'moving' sound. There are five types of boxes (featuring different sounds) and only four spaces on the tray. The location of each moving box is represented by sound volume (Y axis) and stereo panorama (X axis). When a box is moving closer to the tray its volume increases. When the player places three boxes of the same type next to each other, they are removed from the tray. After sorting a certain number of boxes, the player reaches a higher level of difficulty and the moving line increases in speed.

When I brought this game into the PhD study, the initial prototype was only partially developed. A significant design challenge was finding effective ways of telling the user which blocks had already been placed in a certain space of the tray. We solved the issue by incorporating an echo sound (as explained in Figure 6.16). As the box (sound A) moves down the line it triggers an echo from the box that is placed below it (sound B). The higher the stack, the higher the pitch of the echo that is heard. The final output reflected this design choice (see Figure 6.17).

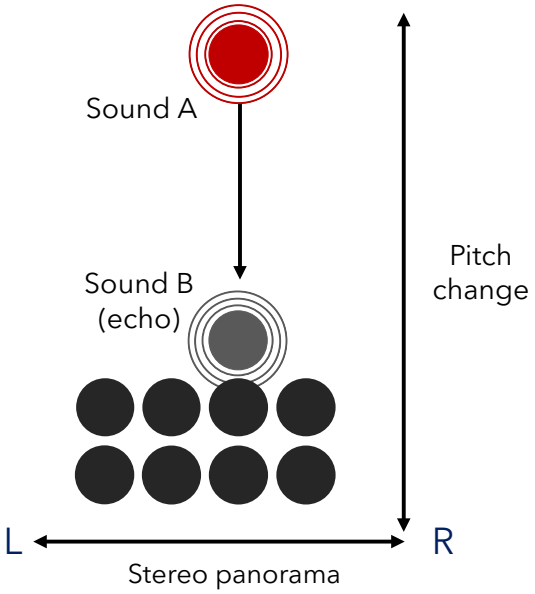


Figure 6.16. Sound implementation of echo mechanism in the game *Blocks*. © Jarosław Beksa.

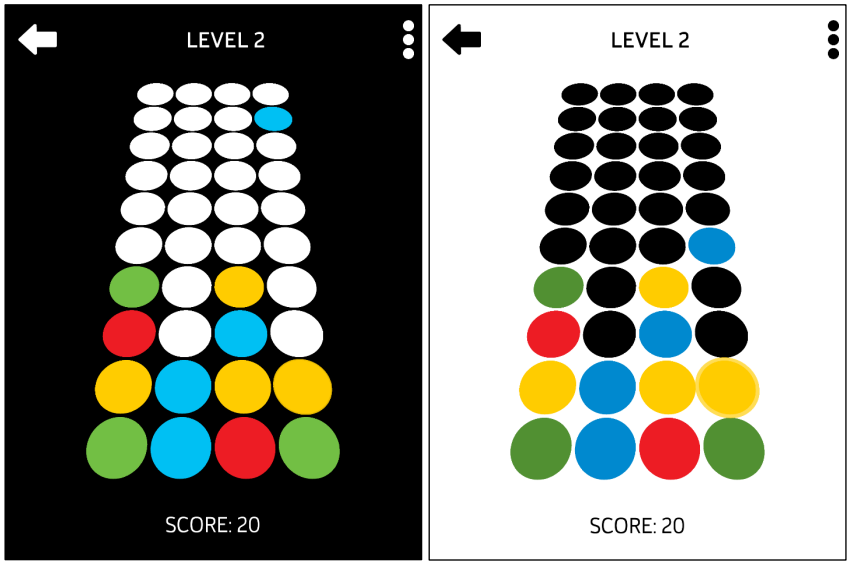


Figure 6.17. *Blocks* game screens. © Jarosław Beksa.

High scores are calculated based on the number of sorted boxes. When playing in Blind Mode the final score quadruples. The reason for a higher score multiplier was that the game was much easier to complete with visual elements evident. While developing the work, the team experimented by playing the prototype to ascertain what ratio of multiplication would be closest to the disjunction of advantage a sighted player might have over one who is visually impaired. There are also achievements to unlock (see Table 6.7).

Table 6.7.
List of available achievements and their descriptions in the Blocks game

Achievement name	Description
Budding builder	Reached level 5 in blind mode
Master builder	Reached level 10
Match maker	Cleared 4 blocks of the same colour
Confidence builds character	Clear 5 blocks of same colour
Block assassin	Clear 2 combos
1001 Blocks on the wall, take one down	Clear 1000 blocks

6.2.8 *Slot Machine*

> *Good evening. Welcome to the Casino Royale. Why don't you warm up with our slot machines?*

Audio 6.11. Slot Machine tutorial and gameplay sample (link). © Jarosław Beksa.

In this game, the player has a chance to experience real-world audio recordings from a casino and play a virtual slot machine. To control the slot machine, the user has to swipe down to pull the lever and swipe left or right to change the bet. There are five different elements on the reel, each represented by a different sound. Each spinning reel is placed in stereo panorama (left, middle and right) and by swiping up the player can receive an update on the winning bets (see Figure 6.18).

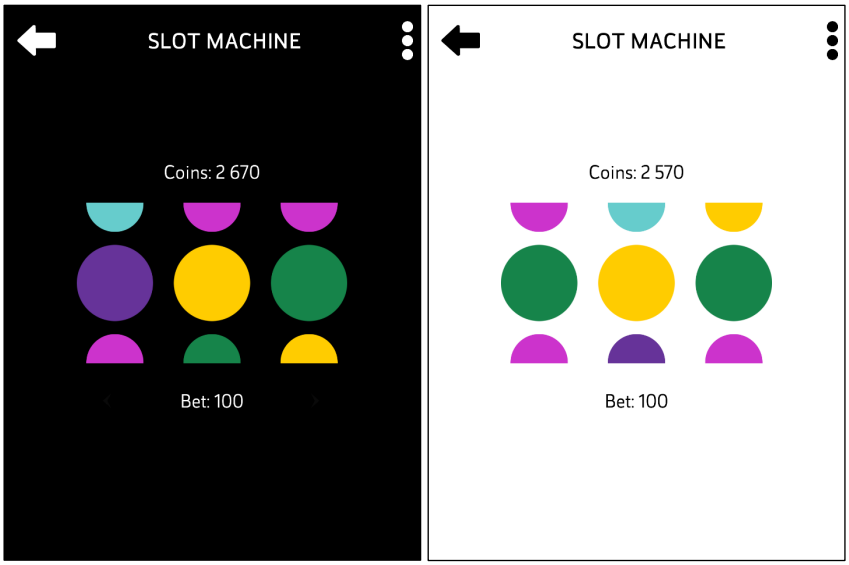


Figure 6.18. Slot Machine game screens. © Jarosław Beksa.

After the initial release, we noticed that many users were submitting astronomically high score results on the project's website. We pulled the game and had to learn how slot machines work in real life, then calculate the odds properly (Barboianu, 2013) to provide a more authentic casino experience.

Although this is the simplest game in *Audio Game Hub 1.0*, it is also one of the most popular (see Appendix E). I am unsure whether this is because it was the first game on the list, or because people enjoy gambling and considerable care had gone into creating an aural simulation of a casino environment.

In *Slot Machine*, high scores are calculated based on the maximum wins. Playing in Blind Mode does not affect the final score. This is because *Slot Machine* is a turn-based game and does not rely on a player's manual or reflex skills. There are also achievements to unlock (see Table 6.8).

Table 6.8.
List of available achievements and their descriptions in the game Slot Machine

Achievement name	Description
Lucky Duck	Won 3 times in a row
Millionaire's club	Won 1 million
Millionaire	Had 1 million coins
Get a life	Played 10 hours in total

6.3 *Audio Game Hub* 2.0

The four games in *Audio Game Hub 2.0* were designed, developed and refined entirely within the thesis study. Prototypes were posted online, with updates made in response to user feedback. I discussed their construction in Section 5.3.2. In this section, I discuss their final format and changes made to them as a consequence of user feedback and supplementary systems of review.

6.3.1 *Blackjack*

> *Good evening. Welcome to the Casino Royale. Please sit down and we'll start a round of Blackjack.*

Audio 6.12. Blackjack tutorial and gameplay sample (link). © Jarosław Beksa.

The game *Blackjack* introduced a new section in *Audio Game Hub 2.0*, casino games. The virtual coins and achievements were shared with the game *Slot Machine*. To simplify the game mechanics, we modified the rules of Blackjack (as played in casinos across the US) by using two decks of cards with no splits allowed (Shackleford, 2015). This decision was criticised by some users (e.g., see Appendix D, review from Robjken and forum post from Amerikranian - 2017-07-16).

The user interface in this game was similar to *Slot Machine*, where the player can hit (swipe up), double the bet (swipe up using two fingers), stand (swipe down), listen to which cards are on the table (single tap) and change the bet (swipe left or right) (see Figure 6.19). This approach reinforced a continuity of experience between the new game (*Blackjack*) and *Slot Machine.*

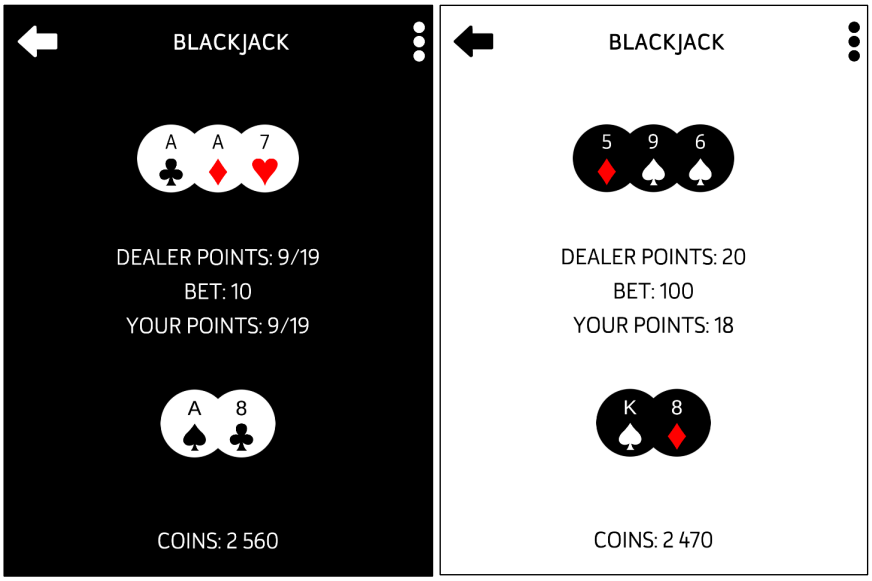


Figure 6.19. Blackjack game screens. © Jarosław Beksa.

Initially, when a player loses all of their money, they need to purchase one of the coin packs or reset their progress. However, user feedback recommended that we implement ways they could receive free coins (e.g., see Appendix D, post from BigGun - 2017-07-14). We followed this advice and implemented daily giftboxes that contained a random amount of free coins. This not only allowed the users to play for free, but also increased game replayability.

High scores in this game are calculated based on the maximum number of wins. Playing in Blind Mode (as in the game *Slot Machine* game) does not affect the final score. There are also achievements to unlock (see Table 6.9).

Table 6.9.
List of available achievements and their descriptions in the Blackjack game (shared with the Slot Machine game)

Name	Description
Lucky Duck	Won 3 times in a row
Millionaire's club	Won 1 million
Nothing to lose	Bet all in 10 times
Get a life	Played 10 hours in total
Let it ride	Bet all in and win

6.3.2 *Bomb Disarmer*

> *Attention squad! It has been reported that there is a serial bomber in New City. As a member of NC's elite bomb squad, you're responsible for keeping the people safe. Respond to the bomb threats and use your skills to disarm the bombs. Each bomb has a growing sequence of sounds. To disarm a bomb, repeat each sequence correctly. Remember, your time is limited, and you have only one chance. Now get to it!*

Audio 6.13. *Bomb Disarmer* tutorial and gameplay sample (link). © Jarosław Beksa.

Bomb Disarmer was inspired by the classic game *Simon* (Hasbro, 1978). In our version, the player becomes a member of an elite bomb squad whose task is to disarm a number of bombs planted in New City. To disarm a bomb, the player needs to repeat a sequence provided via radio transmission. The sequence sounds like tones on a public telephone.[231] Each bomb has a timer that reinforces the sense of urgency during the neutralising process, and some bombs require more than one sequence to disarm them. Unlike Hasbro's game *Simon*, where each new sequence creates an additional sound to the previous sequence, in our game each new sequence is randomly generated. After the player completes the storyline, by disarming all of the bombs, an endless mode is activated, with sequences growing indefinitely. This encourages multiple plays of the game and competition between players as they try to achieve the highest score.

This game was significantly shaped by feedback from blind and visually impaired players who told us that they were seeking games they could play with groups of sighted friends. As a consequence, in *Bomb Disarmer* two multiplayer modes were implemented, where player A, after their round, has to pass the device to player B (so the game is progressed through an oscillation of play).

In Versus Mode, players compete with each other to determine who can remember the longest sequence. In Elimination Mode, if a player makes a mistake they are eliminated and

[231] Telephone dial pads use DTMF (Dual Tone Multi Frequency) signals (Onlinetonegenerator.com, 2011).

the last player to stay in the game wins. These modes were inspired by the game *Pass the Bomb*, released by Piatnik in 1994 (see Figure 6.20).

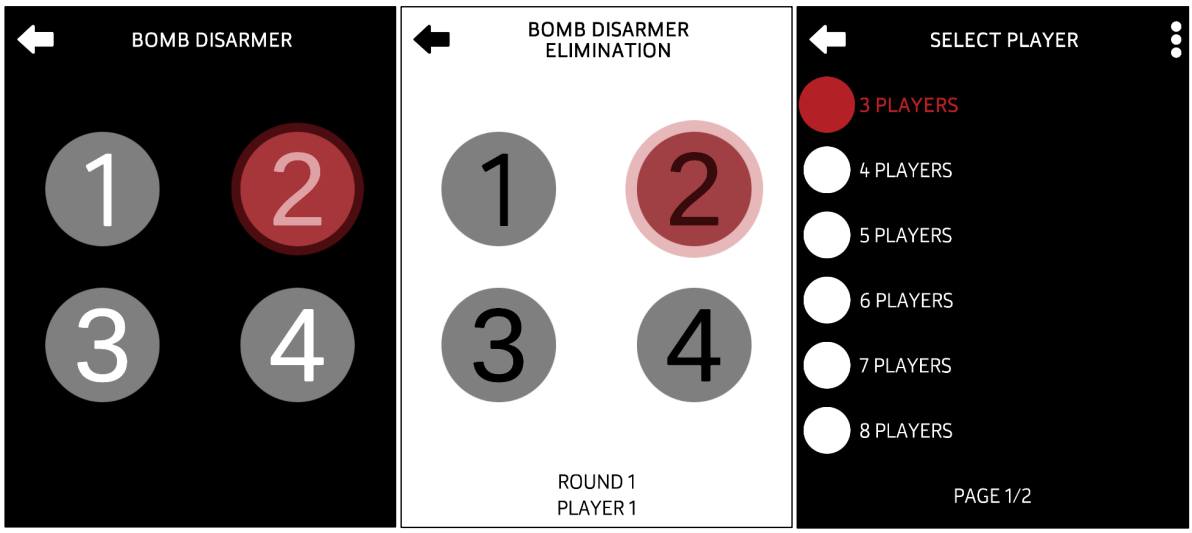


Figure 6.20. Bomb Disarmer game screens. © Jarosław Beksa.

Some players also told us that the telephone tones were difficult to distinguish (e.g., see Appendix D, post from Sebby - 2017-07-17). In response, I modified their pitch. That being said, this is an issue on which I received contradictory feedback, because there were also users who enjoyed the original tones, finding them useful in improving DTMF tone recognition (e.g., see Appendix D, forum post from Musicalman - 2017-07-14).

In *Bomb Disarmer*, high scores are calculated based on the number of disarmed bombs. When playing in Blind Mode the final score is doubled. There are also achievements to unlock (see Table 6.10).

Table 6.10.
List of available achievements and their descriptions in the Bomb Disarmer game

Name	Description
Graduation Day	Finished bomb squad tutorial
Promoted to Captain	Disarm 10 bombs
Like your life depends on it	Disarm 50 bombs
Promoted to Chief	Disarm 100 bombs
Don't cut the red wire!	Complete a sequence 10 sounds long
Saviour of the city	Complete a sequence of 20 sounds long

6.3.3 *Super Simon*

> *Welcome to the classic Simon. Your task is to repeat a specified sound sequence within a short time frame.*

Audio 6.14. Super Simon tutorial and gameplay sample (link). © Jarosław Beksa.

Super Simon is a remake of the classic *Simon* game and follows the same rules. The player's task is to repeat specified sound sequences (see Figure 6.21). In each new round, a new sound is added at the end of the previous sequence. Our version introduced over 40 sound packs from which players could select, including musical instruments, animal sounds, explosions and human sounds (e.g., burps or screams). The sound packs can be unlocked for free, through daily gift boxes, by completing achievements or via in-app purchases. Like *Bomb Disarmer*, *Super Simon* was designed as a multiplayer game that allows up to 10 players in Versus or Elimination Mode.

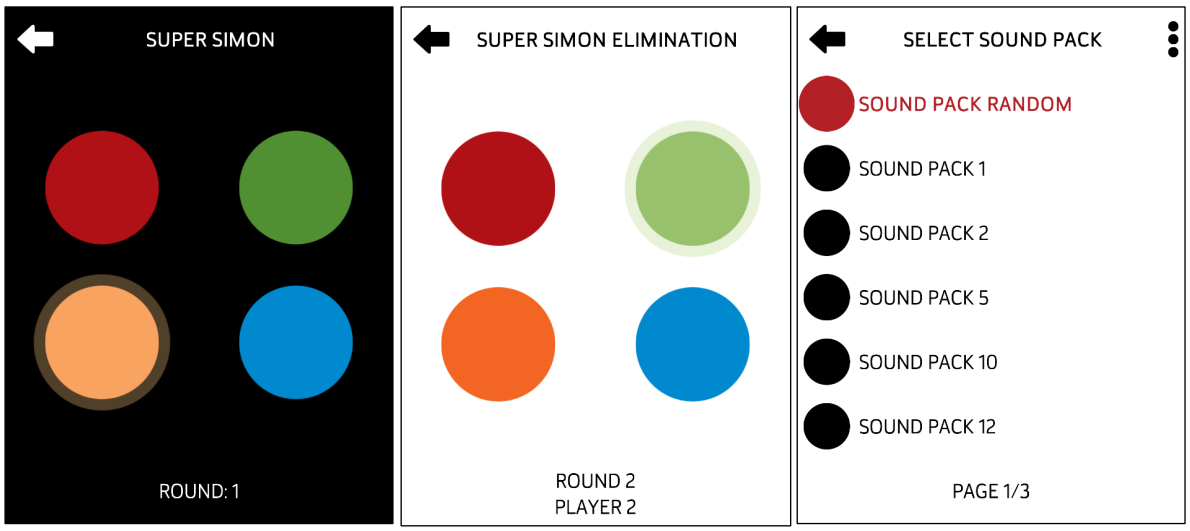


Figure 6.21. Super Simon game screens. © Jarosław Beksa.

High scores are calculated based on the number of repeated sequences. When playing in Blind Mode the final score is doubled. *Super Simon* does not contain any unlockable achievements.

6.2.12 *Animal Escape*

> *Your goal is to run as far as you can from Joe the driver before he catches you and takes you back to the animal farm. Watch out for trains and cars...*

Audio 6.15. Animal Escape tutorial and gameplay sample (link). © Jarosław Beksa.

Animal Escape was inspired by the game *Crossy Road* (Hipster Whale, 2014)[232] and was the second audio game where we introduced 3D graphics. In this game, the player's task is to run away from an animal transport truck and avoid being caught by Joe the driver. During the escape, the player crosses diverse terrains including grass, roads and train tracks (each of them are represented by a different footstep sound). The roads and train tracks are teeming with vehicles that can run a player over and kill them (see Figure 6.22).

Figure 6.22. Animal Escape game screens. © Jarosław Beksa.

[232] https://www.hipsterwhale.com/.

To increase the sense of realism, the Doppler Effect[233] was used to simulate the sense of moving vehicles. The game environment is divided into five vertical lanes, placed in stereo panorama (far left, left, middle, right and far right) (see Figure 6.23).

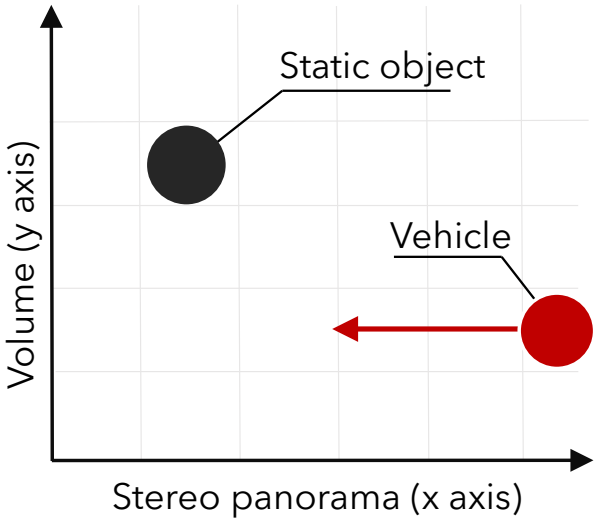


Figure 6.23. Audio mechanics design in the game *Animal Escape*. © Jarosław Beksa.

Each of the five lanes features randomly placed objects (e.g., a tree or a coin). A specific sound represents each object and it becomes louder the closer the player moves towards it. A challenge we faced in the posted prototype was that players were often unable to distinguish between two identical objects placed in two different places on a horizontal lane. For example, two coins placed in the far left and far right would sound like one coin on the middle lane. We resolved this through iterative experiments by modifying objects' sound pitch and play delay time.[234]

The coins in this game are used to increase the overall score and activate the superpower Chickenzilla. This power causes the player's character to grow large for 10 seconds, making them invincible for that period of time.

High scores are calculated based on the number of forward jumps and collected coins. When playing in Blind Mode the final score is multiplied by five. As in the game Blocks, we

[233] The Doppler effect is a frequency change of sound, light or other waves as the source of the observer moves towards or away in proximity (NASA, n.d.).
[234] The coins embodied different pitched sounds and were played asynchronously.

estimated the multiplayer value by blindfolding ourselves and testing ratios within the team. There are also achievements to unlock (see Table 6.11).

Table 6.11.
List of available achievements and their descriptions in the game Animal Escape

Name	Description
Chicken Nugget	Gather 1000 coins in total
Chicken Runner	Get over 100 lines
Road Runner	Get over 200 lines
Where are you chicken?	Get caught by Joe
Ninja Chicken	Get over 100 lines in Blind Mode
Master Ninja Chicken	Get over 200 lines in Blind Mode
Kentucky Fried Chicken	Get hit by a truck
Half a Chicken	Get hit by a train
Chickenzilla!	Enable your special power

6.4 *Blind Cricket*

Ever dreamt of representing your country at the Cricket World Cup? Close your eyes and imagine yourself on the big stage. Your time has come... Play the Blind Cricket game and find yourself immersed in an audio-rich world. Play on your own or with teammates to make it from school level to international cricket. Or you could play against each other to see who finishes on top.

Audio 6.16. Blind Cricket tutorial and gameplay sample (link). © Jarosław Beksa.

Video 6.3. Trailer video for the game *Blind Cricket* (YouTube link). © Jarosław Beksa.

In *Blind Cricket*, the player's goal is to advance through school and domestic cricket levels to an international level, eventually leading their team to the world championships. Each level features a unique ambience design (crowds, chanting and commentators) to increase the level of immersion. On each level, the player needs to acquire a certain number of runs (this action is in accordance with the Blind Cricket NSW Inc. regulations). Inside the blind cricket ball there are small bells or other items that make sounds when the ball is rolling. To localise the ball, we used stereo panorama and the Doppler Effect (NASA, n.d.). These can be employed to change the sound frequency of a moving object. At the right moment, the player needs to hit or block a ball that can come at them from different directions (see Figure 6.24). To hit the ball, the player can swipe left, up or right on the screen (depending on the ball's direction). To block, they must press and hold their finger on the left, middle or right side of the screen. As an option, gestures can be replaced with swings and tilts of the device. To achieve this function we used a built-in accelerometer and gyroscope (Su et al., 2014). However, internal tests indicated that swing and tilts do not work properly on some mobile devices, so I appreciate that the function may improve as the technology on these devices advances. *Blind Cricket* can be played by up to 11 players (equating to an entire cricket team) in 'Hot Seat' mode (by taking turns and passing the device between players).

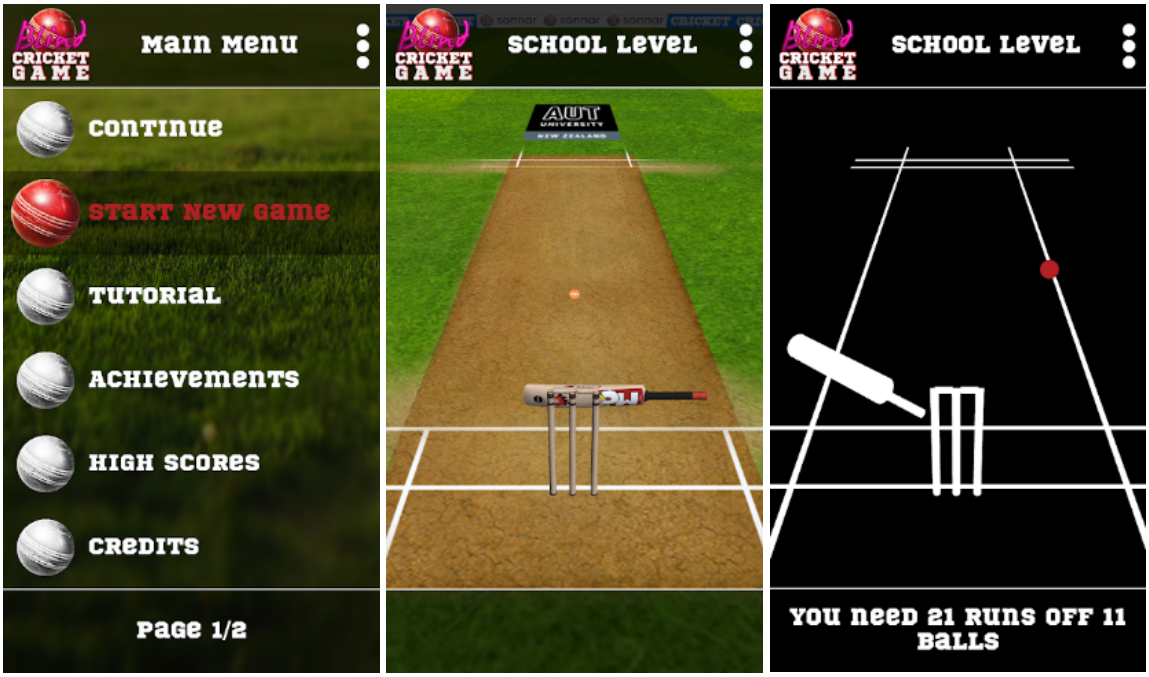


Figure 6.24. Blind Cricket game screens. From the left: main menu, gameplay, gameplay in High Contrast Mode. © Jarosław Beksa.

In practice mode, players can familiarise themselves with the game controls and learn how to strike the ball at the appropriate moment. A guiding sound is available that reaches maximum pitch at the perfect moment of a hit.

High scores are calculated based on the number of runs in each competition. When playing in Blind Mode, the final score is doubled. There are also achievements to unlock (see Table 6.12).

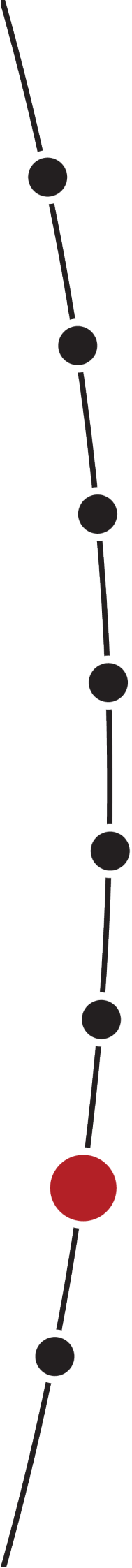
Table 6.12.
List of available achievements and their descriptions in the Blind Cricket game

Name	Description
World Class Cricketer	Completed in Career mode
Stevie Wonder – Master Blaster	Completed the career in Blind mode
Batter's Dozen	Had 4 runs – 3 times in a row
Six Machine	Had 6 runs – 3 times in a row
Team of Champions	Completed the Career mode with 11 players
Audio Donor	Donate any amount
Centurion!	Scored 100 runs in one match
Glutton for Punishment	Hit 1,000 balls in total
Malcom Gladwell Award	Hit 10,000 balls in total

6.5 Overview

The 13 games developed for this thesis are concerned with play. They are designed to elevate excitement, community and the pursuit and realisation of achievement. They may be intimate or collective, but their effectiveness relies on carefully designed and refined aural attraction and functionality.

Heraclitus (Dursun, 2007) , Thomas Aquinas (Whidden, 2016), Kant (2007), Gadamer (1987) and Huizinga (1949) do not perceive 'play' as something inconsequential or peripheral to the human condition. If we consider the word's Proto-West Germanic etymology (*plegōjanan*), play means to 'occupy oneself about'. Alternatively, if we reflect on the Old Saxon word (*plegan*), it means 'to take charge of' (Online etymology dictionary, 2020). The games in *Audio-Game Hub 1.0* and *2.0* and the game *Blind Cricket* provide spaces where visually impaired, blind and sighted players can be 'occupied', 'taking charge' of opportunities in a designed environment where people compete using their ability to hear and react. The games are challenging. They elevate excitement and reward. They pose playful scenarios and the skills they call forward are advanced. These games do not patronise because they are designed to exercise the sophistication of applied talent. Since they are developed primarily for blind or visually impaired players, they generally feature restrained visual elements. The complexity of their design resides in the arrangement of sound.



Summary and conclusion

In 1949, Johan Huizinga wrote in his discussion of the role of play in culture:

> The spirit of playful competition is, as a social impulse, older than culture itself and it pervades all life like a veritable ferment. Ritual grew up in sacred play; poetry was born in play and nourished on play; music and dancing were pure play … We have to conclude, therefore, that civilization is, in its earliest phases, played. It does not come from play … it arises in and as play, and never leaves it. (p. 173)

In 2000, Stephen Scrivener suggested in his description of Creative Production research in doctoral studies that such inquiry is 'inventive and imaginative, and realised through artefacts' (p. 15). These artefacts he proposed are novel and positioned within a cultural context. I believe that play is fundamental, and this thesis project has been concerned with a particular kind of play: play as cultural belonging, for players and designers/developers. Both occupy the same cultural context (gaming), regardless of physical enablement. From this position they can speak together, supporting each other in the pursuit of quality outcomes. Thus, in this study, I have asked a single question that I sought to address through practice:

> How can games for people with visual impairments be designed, developed and refined through the use of iterative online feedback; by an Indie Designer/Developer who operates outside of conventional game design methodologies?

Pursuing this question, two dimensions (the design of games and the practice of independent design and development) have been drawn together in a thesis. In truth, the project initially had a challenge finding a home because the study drew on considerations of game design, leadership, financing and heuristic inquiry. Here the progress of games and the progress of a protean team were interconnected in a project shaped by the availability of resources and vision of enablement.

Looking back, the exegesis can probably be described as a post-disciplinary inquiry. Wright, Embrick and Henke (2015) suggest that 'post-disciplinary studies emerge when scholars forget about disciplines and whether ideas can be identified with any particular one: they identify with learning rather than with disciplines' (p. 271). Darbellay (2016) sees post-disciplinary research in more radical terms. He proposes that such studies 'rethink' the concept of a discipline, suggesting that when researchers pursue projects outside of disciplines, they 'construct a new cognitive space, in which it is no longer merely a question

of opening up disciplinary borders through degrees of interaction/integration, but of fundamentally challenging the obvious fact of disciplinarity' (p. 367).

Finding an authentic post-disciplinary cognitive space for the project was important. Although the thesis deals with a project and a demarcated span of time, formally it can be described as a study conducted between 2015 and 2018 when the games were developed and refined. This frame was then extended into 2019 and 2020 when, from copious notes and files, I set about writing an exegetical reflection on what I had discovered. However, the passion driving the research runs back much further, through the Gamification Lab in Germany, through a discussion with a visually impaired gamer, and into the domestic spaces where I fell in love with digital game playing in my childhood.

In the end, I positioned the thesis as a practice-oriented inquiry in Art and Design, and more specifically, inside the concept of Creative Production research. This exegesis has sought to outline the context of the research and the methodological approach. It has then progressed into a form of narration that offers a reflection on an uneven journey. This is because, in trying to account for the nature of indie design and development, one cannot escape the impacts of spasmodic funding and working without templates. In reflection, I realise that I cannot account for everything in the study, but a lens has been pulled so a series of foci draw into perspective the picture of a critical and committed inquiry.

7.1 Project summary

7.1.1 Project scope and recognition

The development of the *Audio Game Hub* and *Blind Cricket* required the involvement of a protean team and a range of supporters. Table 7.1 provides an overview of the project's scope and Table 7.2 outlines the project's level of international recognition.

Table 7.1

Numerical summary of the project's scope (Audio Game Hub and Blind Cricket)

Number of games	13
Number of updates (releases)	*Audio Game Hub*: 20 *Blind Cricket*: 16
Number of sound files	Total: 1,764 Voice files: 720 Sound effects: 964 Music files: 80
Number of lines of code	92,482
Number of people involved in the development	Total: 20 Germany: 7 New Zealand: 13
Number of voice actors	Total: 13 Germany: 6 New Zealand: 7

Table 7.2

Summary of the project's recognition (Audio Game Hub and Blind Cricket)

Number of national and international awards	6 (see Table E.6).
Number or national and international conference presentations	3 (see Table E.7).
Google Search Engine results	The search term 'Audio Game Hub' in the Google search engine on 16 June 2018 returned 6,890 results.
Media coverage	The project was widely discussed in online articles, on podcasts, and in video reviews, blog posts, news and national television interviews. A selection of 30 examples are provided in Table E.8.
Number of YouTube videos posted about the *Audio Game Hub*	On 18 June 2018, the search phrase 'audio game hub' returned over 900 results on YouTube. These videos were viewed more than two million times collectively. An extract of YouTube videos with over 1,000 views is presented in Table E.9.

7.1.2 Project costs

Although the project garnered significant levels of recognition within the gaming community and the games continue to be played, financially, the journey was turbulent and the games only came into being because of the tenacity and generosity of committed people.

Table 7.3 provides an overview of the actual costs, because the information may be helpful for future Indie Designers/Developers, investors and research institutions. It may also provide users with insight into the production costs of games.

Table 7.3
Summary of the project's total costs (approximate)

Salaries and contractors	173,000 NZD
Music, sound effects and voice recordings	10,000 NZD

7.1.3 Revenue and downloads

Over two years of data collection, the *Audio Game Hub* and *Blind Cricket* were downloaded over 130,000 times (see Table 7.4) and generated over 26,000 NZD in revenue (see Table 7.5). Detailed information about user demographics, behaviour and reviews are presented in Appendix E.

Table 7.4
User and usage overview summary of Audio Game Hub and Blind Cricket games (15 April 2016 – 16 June 2018)

	Platform	Users	Sessions	Screen views	Screens per session	Average session duration
Audio Game Hub	Android	39,093	200,920	2,191,605	10.91	00:12:03
	iOS	23,732	190,129	1,682,901	8.85	00:09:34
	Windows	4,124	17,937	129,971	7.25	00:08:42
Blind Cricket	Android	60,113	129,899	1,277,203	9.83	00:13:04
	iOS	4,988	27,367	242,453	8.86	00:11:02
Total/Average		132,050	566,252	5,524,133	9.14	00:10:53

Source: Google Analytics.

Table 7.5
Summary of revenues and pay-outs of Audio Game Hub and Blind Cricket split across platforms (15 April 2016 – 16 June 2018)

Game	Platform	Revenue (NZD)	Pay-out (NZD)
Audio Game Hub	Android	5,390	3,802
	iOS	27,867	19,615
	PC Windows	0	0
Blind Cricket	Android	754	533
	iOS	4,114	2,930
TOTAL		38,126	26,882

Considering the number of sessions and average session time up until 16 June 2018 (when the practical component of the thesis was paused), the games were played for a total of 102,711 hours (equivalent to 4,279 days or 11.7 years).

7.2 Contributions to the field

Given the nature of this inquiry the contributions to the field are indicative but not proven. Accordingly, the propositions are tentatively stated.

The thesis was driven by two objectives. Through a practice-oriented inquiry I sought to create a set of accessible, player-valued audio games for people with visual impairment and blindness (and their sighted friends and family). In addition, I set out to explore how an Indie Designer/Developer might create a model for collaborative game development based on ideas like shared values, belonging and voluntary feedback. These elements functioned in the realm of restricted or oscillating financial support that is indicative of much indie design and development.

Therefore, I suggest that the study may make two contributions to the field. First, the *Audio Game Hub* and *Blind Cricket* may have increased awareness of the needs of people with disabilities and enhanced the nature of play by providing better and more accessible games (see Appendix D for indicative examples). As such, the games may have resourced

social situations in which visually impaired gamers have been able to play and interact with non-sighted and sighted peers (see Appendix D).

Second, in positing and applying the concept of an Indie Designer/Developer, the study shows how one may operate as a post-heroic, generalist leader who develops an integrated attributing approach with a team. In this team, design thinking is resourced through a blend of tacit knowing, embodied experimentation and critical reflection on data sourced from online feedback. This claim is made in light of this thesis (as a case study) and is therefore applicable solely to the project. However, as a case study the application of Indie Design/Development may prove to be of interest to wider applications.

7.3 What have I learned?

The following lessons emerged over the course of the project:

- Based on the number of downloads and user feedback, the project has demonstrated that there is a demand for audio games for visually impaired people.
- A successful audio game may mean different things to different people, but feedback and statistics suggest that it must be engaging, liked by users and functional.
- Reflecting on the overall project outcomes, we were not able to generate sufficient revenue to recuperate initial investment and cover ongoing development costs. However, through experimenting with monetisation techniques in the latter phase of the project, I was able to verify that there is a willingness from users to pay for our games. The extent to which independent audio games may be commercially sustainable is an area that warrants future investigation.
- It appears that audio games also appeal to sighted people. Initial indications show that gameplay without vision is perceived as stimulating imagination. Feedback also suggests that the ability to play with non-sighted users provides the same level of enjoyment and engagement for both groups. However, these insights are tentative and further research through artefact development and reflection on usage is necessary.
- Games can be successfully developed and refined inside online feedback loops. Effective design is not predicated on following templated guidelines for audio game

development.[235] However, guidelines and theoretical discourses emanating from academic research make for valuable reading because they can provide context and evidence from non-commercially influenced experiments.

- It may be more useful in future iterations of such research to release the games one by one, instead of waiting for all of them to be completed. This will allow gamers' interest to build up, and their feedback can have more impact on emerging prototypes.
- It may be more effective to implement in-app purchases early to gain extra funds for the games.
- We would have been better off implementing our own leader boards because while Google Play Games (Google LLC, n.d.) and Apple's Game Center (Apple Inc., n.d.) solved the account and login creation issues, it caused significant compatibility problems with the Unity 3D libraries. They were also vulnerable to hacking (experienced users with custom firmware [non-official operating system] could easily modify any value in the leader boards, resulting in astronomical scores).
- Funding tools like Kickstarter require thorough preparation. In hindsight, we should have begun promoting the campaign at least four weeks beforehand.
- As an Indie Designer/Developer, when working with new team members, it is important to be very clear about the vision and discuss the unstable nature of the approach. Due to limited resources typical to Indie Development, the constitution and capability of the team is paramount. My experiences led me to value team member's existing skills and their future potential; it is important to accurately assess the competency of new team members. Similarly, there is no necessary correlation between size of the team and productivity, so one should not assume that having a larger team will result in more effective development. In this regard, I was reminded that Brooks (1995), in his *The mythical man-month*, notes that adding four developers will not necessarily increase the development speed by four times.
- Indie design and development is challenging. Although the *Audio Game Hub* is not yet sustainable financially, it has attracted considerable attention and created new opportunities for us. We received a nomination at the Google Play Awards (2018) in the Best Accessibility Experience category. Further, I was invited to partner with Blind Low Vision NZ to work on their Accessible Voice Platform. We are looking forward to a future of diverse engagements.

[235] By working independently, I was able to create immersive and playable audio games. I was expecting around 10,000 downloads and by June 2018 the games had generated over 130,000.

7.4 Future research

Figure 7.1 is a picture taken after the Kickstarter campaign in 2016. It shows a team of people facing a future. This thesis is a living thing; as a result, it is designed to reach outwards and faces a future that is constantly evolving. I believe that the study has two trajectories for future research: potential advancements of the *Audio Game Hub* and published articles and conference presentations that may serve to disseminate knowledge within the study.

Figure 7.1. Audio Game Hub 2.0 team in 2016. Included are Vincent Polewidhi, Jeong Su Jeon, David Delgado, Jarosław Beksa and Yiding Liu. © Jarosław Beksa.

7.4.1 Potential future work for *Audio Game Hub*

We will implement the Unity 3D UI Accessibility plugin[236] (Metalpop Games, 2017) that provides compatibility with screen readers such as VoiceOver and TalkBack. This will give players a choice between a self-voiced interface or one that is native. This plugin will also enable the use of a system keyboard without the need to exit the game. This could be used to input user data such as a login or password and for in-application text messaging. The

[236] https://assetstore.unity.com/packages/tools/gui/ui-accessibility-plugin-uap-87935.

plugin will also allow us to handle system events such as incoming text messages, phone calls or notifications.

I intend to implement cross-platform leader boards and achievements. Currently, users playing on iOS devices cannot share their results with users playing on Android phones. We should implement online multiplayer modes for existing games that will allow users to play with their peers remotely.

We will add support for more languages. Google Analytics has revealed that there are a significant number of gamers from non-English speaking countries. We have received multiple requests to translate the games into Spanish, Portuguese and Russian languages (e.g., see Appendix D, reviews from Wenderson Cruz and Efraín Hernández).

We will experiment with the implementation of augmented and virtual reality audio (3D binaural sounds). This will allow experimentation with new game play mechanics that utilise VR and AR headsets, and hardware sensors in mobile devices (such as gyroscope and accelerometers). By doing this, I will be pursuing designs that create more immersive experiences.

We should add speech controls as another way to interact with the games (e.g., giving voice commands instead of touching the screen). We will port games to Amazon Alexa and Google Home Devices. Smart speakers' growing popularity and accessibility (using a voice interface) makes them an attractive platform for playing games (Cicció & Quesada, 2018; Kinsela, 2019). Our team has already developed the game *Bomb Disarmer* for Amazon Alexa devices.[237] This game is currently receiving positive reviews from both visually impaired and sighted users.

The next game we intend to develop is called *Runner*. Currently, I estimate the prototype requires one more month of development. This is the last of the nominated games in the Kickstarter campaign. Once this is completed, we will consider a new suite of games based on feedback to date.

Finally, I am considering opening the *Audio Game Hub* up to external developers who might like to include their games in the catalogue. However, as a team, we have not yet discussed the criteria that might surround inclusion.

[237] https://www.amazon.com/Sonnar-Interactive-LTD-Bomb-Squad/dp/B07H3H93XZ.

7.4.2 Published articles and conference presentations

Although I have already published three papers from this study,[238] I am currently considering contributions that I might be able to offer to current academic discourses. Building on recently published literature reviews relating to audio game design (Nesteriuk, 2018; Urbanek & Güldenpfennig, 2019a), I may be able to offer something useful that reviews audio game research in relation to inclusive and accessible design, gameplay mechanics and audio game engines and development tools.

I am also considering (when COVID-19[239] restrictions on travel are lifted) submitting papers to conferences that deal with the role and nature of audio design. Indicative of these are the 2021 iteration of the Austrian IEM/University of Music and Performing Arts's Audio Mostly - In Extended Realities Conference that will run from 15 to 17 September.[240] I am also considering a paper for the 2021 Game Developers' Conference (GDC 2021). This work might unpack the development and context of the game *Blind Cricket* (as a case study). The paper would interface with the conference's focus on 'the development of connected and cloud gaming including free-to-play web games'.[241]

Finally, I am interested in publishing work around independent game design and development. My intention is to contribute a case study (drawing on this thesis) that might contribute to emerging commentary already advanced by Garda and Grabarczyk (2016), Latorre (2016), Lipkin (2013), Michael (2003) and Perez (2019).

7.5 In parting

I have learned that independence does not mean doing something by yourself. Each team member and stakeholder became a piece of the puzzle as they helped influence, shape and complete the project. Without their contributions, the *Audio Game Hub* and *Blind Cricket* would not be what they are today.

[238] See the list of publications in the preliminary pages.
[239] https://www.who.int/emergencies/diseases/novel-coronavirus-2019.
[240] https://audiomostly.com/.
[241] https://www.gdconf.com/about-gdc.

I have also learned about myself; about the people around me; and about being a researcher, developer, artist, leader and publisher. In this project, I fell in love. I fell in love with making games for people who are physically different to me. I fell in love with a process predicated on the care of people. I fell in love with the instability, euphoria and pain of independent design and development. I have come to believe in the viability of these things, even if I was not consistently successful. I believe that artists and designers who continue to make work outside of (and thereby suggest alternative pathways to) what is offered by AAA production, distribution and publishing, contribute something important. Although mid-sized and major publishers have significantly more infrastructure and more stable development and marketing budgets, they often perceive gamers as 'end users', statistics and trends.

In this project, we wrote to and received correspondence and support from hundreds of people who voluntarily shared both their responses to our designs and aspects of their lives. They talked with us about aspiration and joy and frustration and context. I understood how uneven distribution of global wealth makes a monetisation option viable in one country and impossible in another. I learned about dignity, humour and irregularity, and I reinforced the wonderful power of play.

I hope that this research may be of use to other Indie Designers/Developers. In writing it, I have tried to craft a voice that will speak to both the academic and gaming worlds that helped to shape the study. It is my intention to eventually publish the exegesis as an audiobook in DAISY format (DAISY Consortium, n.d.) so visually impaired people can access the information.[242] I hope that the study might also inspire future Indie Game Designers/Developers to follow their own aspirations. They might take from this exegesis insights or experiences that work for them and thereby save valuable time and energy on their journey.

I opened this exegesis with lines from the Polish singer and songwriter Marek Grechuta. In his song *Dni, których nie znamy*, he talks about the importance of what is not yet realised. Although I am submitting this thesis, the journey is not finished; I have audio games yet to create, people still to listen to and learn from, and levels of understanding still to reach.

[242] Technically, this will involve engaging a voice artist and securing a recording studio. The final production can then be implemented inside the *Audio Game Hub* and made available free of charge on the project website.
Early experiments into how this might be realised are integrated with this pdf exegesis. For example, I have already added "alt text" to images so blind people can read the diagrams.

I close this exegesis with Marek Grechuta's insight:

Ważne są tylko te dni, których jeszcze nie znamy
Ważne jest kilka tych chwil, tych, na które czekamy

Only those days which we do not know yet count
Only those few moments which we are waiting for are important

Marek Grechuta (1971, translated by Lach, 2017)

Like many Indie Designers/Developers, I pursue what I do not know. Grechuta reminds me about the optimism and courage that underpins the spirit of such inquiry.

References

Accessibility Chatter. (2012). *PDF accessibility testing with JAWS, NVDA and Window-Eyes – Accessibility Chatter*. http://accessibilitychatter.com/?p=18

AFB. (n.d.). *Low vision and legal blindness terms and descriptions*. American Foundation for the Blind. https://www.afb.org/blindness-and-low-vision/eye-conditions/low-vision-and-legal-blindness-terms-and-descriptions

Afonso, A., Blum, A., Jacquemin, C., Denis, M. & Katz, B. F. G. (2005). *A study of spatial cognition in an immersive virtual audio environment: Comparing blind and blindfolded individuals*. https://smartech.gatech.edu/handle/1853/58424

Allain, K., Dado, B., Gelderen, M. V., Hokke, O., Oliveira, M., Bidarra, R., Gaubitch, N. D., Hendriks, R. C. & Kybartas, B. (2015). An audio game for training navigation skills of blind children. In *2015 IEEE 2nd VR Workshop on Sonic Interactions for Virtual Environments (SIVE)* (pp. 1–4). https://doi.org/10.1109/SIVE.2015.7361292

Andrade, R., Rogerson, M. J., Waycott, J., Baker, S. & Vetere, F. (2019). Playing blind: Revealing the world of gamers with visual impairment. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (pp. 1–14). https://doi.org/10.1145/3290605.3300346

Anthropy, A. (2011). *Beyond indie*. https://web.archive.org/web/20161228000021/http://auntiepixelante.com/?p=960

Anthropy, A. (2012). *Indie game: The movie*. https://web.archive.org/web/20150717180646/http://auntiepixelante.com/?p=1556

Apple Inc. (n.d.-a). *Accessibility—Apple developer*. https://developer.apple.com/accessibility/

Apple Inc. (n.d.). *Audio Game Hub*. App Store. https://apps.apple.com/us/app/audio-game-hub/id1101972684

Apple Inc. (n.d.-b). *Vision accessibility—IPhone*. Apple (New Zealand). https://www.apple.com/nz/accessibility/iphone/vision/

Araújo, M. C. C., Façanha, A. R., Darin, T. G. R., Sánchez, J., Andrade, R. M. C. & Viana, W. (2017). Mobile audio games accessibility evaluation for users who are blind. In M. Antona & C. Stephanidis (Eds.), *Universal access in human–computer interaction. Designing novel interactions* (pp. 242–259). Springer International Publishing. https://doi.org/10.1007/978-3-319-58703-5_18

Arcade Museum. (n.d.). *Touch me*. https://www.arcade-museum.com/game_detail.php?game_id=12694

Archambault, D. (2004). The TiM Project: Overview of results. In K. Miesenberger, J. Klaus, W. L. Zagler & D. Burger (Eds.), *Computers helping people with special needs* (pp. 248–256). Springer. https://doi.org/10.1007/978-3-540-27817-7_38

Arguello, D. (2018, October 21). *How crunch affects the lives of game developers*. Digital Trends. https://www.digitaltrends.com/gaming/how-crunch-affects-game-developers/

Atkinson, M. T., Gucukoglu, S., Machin, C. H. C. & Lawrence, A. E. (2006). Making the mainstream accessible: Redefining the game. In *Proceedings of the 2006 ACM SIGGRAPH Symposium on Videogames* (pp. 21–28). https://doi.org/10.1145/1183316.1183321

AudioGames.net. (n.d.-a). *AudioGames, your resource for audiogames, games for the blind, games for the visually impaired!* https://audiogames.net/list-games/

AudioGames.net. (n.d.-b). *Real sound—Kaze No Rigtet*. https://www.audiogames.net/db.php?action=view&id=realsoundkazenoregret

Azerrad, M. (2012). *Our band could be your life: Scenes from the American indie underground, 1981-1991*. Little, Brown and Co.

Bălan, O., Moldoveanu, A., Moldoveanu, F. & Dascălu, M.-I. (2014). Navigational 3D audio-based game-training towards rich auditory spatial representation of the environment. In *2014 18th International Conference on System Theory, Control and Computing (ICSTCC)* (pp. 682–687). https://doi.org/10.1109/ICSTCC.2014.6982496

Balan, O., Moldoveanu, F., Moldoveanu, A. & Butean, A. (2015, September 24). *Developing a navigational 3D audio game with hierarchical levels of difficulty for the visually impaired players* [Paper presentation]. Romanian Conference on Human Computer Interaction - RoCHI 2015, Bucharest, Romania. https://www.researchgate.net/publication/283071079_Developing_a_navigational_3D_audio_game_with_hierarchical_levels_of_difficulty_for_the_visually_impaired_players

Bannick, J. (n.d.). *Blind computer games—guidelines*. http://www.blindcomputergames.com/guidelines/guidelines.html

Barboianu, C. (2013). *The mathematics of slots: Configurations, combinations, probabilities*. INFAROM.

Barlet, M. C. & Spohn, S. D. (2012). *A practical guide to game accessibility.* The AbleGamers Foundation. https://accessible.games/wp-content/uploads/2018/11/AbleGamers_Includification.pdf

Bateman, C. (2009). *Beyond game design: Nine steps towards creating better videogames* (1st ed.). Charles River Media.

Beck, Kellen. (2019). *How video game development has changed over the last decade*. Mashable. https://mashable.com/article/video-game-development-over-the-decade/

Beeston, J., Power, C., Cairns, P. & Barlet, M. (2018a). Characteristics and motivations of players with disabilities in digital games. *ArXiv:1805.11352 [Cs]*. http://arxiv.org/abs/1805.11352

Beeston, J., Power, C., Cairns, P. & Barlet, M. (2018b). Accessible player experiences (APX): The players. In K. Miesenberger & G. Kouroupetroglou (Eds.), *Computers helping people with special needs* (pp. 245–253). Springer International Publishing. https://doi.org/10.1007/978-3-319-94277-3_40

Beksa, J., Majewski, K. & Sadowski, R. (2011, February 2). *Multiplatform audio game* [Paper presentation]. Audio Engineering Society Conference: 41st International Conference: Audio for Games. http://www.aes.org/e-lib/browse.cfm?elib=15763

Bies, B. (2017). *Indie gaming: Finding entrepreneurial success in video games*. New Degree Press.

Blind Cricket NSW Inc. (n.d.). *Rules of Blind Cricket—New South Wales*. http://www.blindcricket.com/blindcricket.html

Bourgeois, C., Maex, K., Scheerlinck, K., Schoonjans, Y., Greene, M., Keer, C. V., Huybrechts, L., Heynen, H., Blythe, R., Verbeke, J., van der Hoeven, F. & Kerckhoven, G. V. (2012). *Good practices/best practices: A manifesto for academic design education and research on creative practice*. KU Leuven.

Bourne, R. R. A., Flaxman, S. R., Braithwaite, T., Cicinelli, M. V., Das, A., Jonas, J. B., Keeffe, J., Kempen, J. H., Leasher, J., Limburg, H., Naidoo, K., Pesudovs, K., Resnikoff, S., Silvester, A., Stevens, G. A., Tahhan, N., Wong, T. Y., Taylor, H. R., Bourne, R., … Zheng, Y. (2017). Magnitude, temporal trends, and projections of the global prevalence of blindness and distance and near vision impairment: A systematic review and meta-analysis. *The Lancet Global Health*, *5*(9), e888–e897. https://doi.org/10.1016/S2214-109X(17)30293-0

Candy, L. (2006). Practice based research: A guide. *Creativity and Cognition Studios Report*, *1*. https://www.researchgate.net/publication/257944497_Practice_Based_Research_A_Guide

Chatzidimitris, T., Gavalas, D. & Michael, D. (2016). SoundPacman: Audio augmented reality in location-based games. In *2016 18th Mediterranean Electrotechnical Conference (MELECON)* (pp. 1–6). https://doi.org/10.1109/MELCON.2016.7495414

Chip.de. (2010). *Raumzeit Folge 1: Der verbotene Sektor iPhone-App*. CHIP Online. https://www.chip.de/downloads/Raumzeit-Folge-1-Der-verbotene-Sektor-iPhone-App_44532112.html

Chugh, R. (2015). Do Australian universities encourage tacit knowledge transfer? In *Proceedings of the 7th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management - volume 1: KMIS* (pp. 128–135). https://doi.org/10.5220/0005585901280135

Cicció, J. A. & Quesada, L. (2018). Framework for creating audio games for intelligent personal assistants. In T. Ahram & C. Falcão (Eds.), *Advances in human factors in wearable technologies and game design* (pp. 204–214). Springer International Publishing. https://doi.org/10.1007/978-3-319-60639-2_21

Cloutier, D. (2017). *'We're gamers too,' says blind video gamer about accessibility in mainstream games*. CBC. https://www.cbc.ca/news/technology/blind-video-gamers-1.4037944

Cohen, Y., Dekker, J., Hulskamp, A., Kousemaker, D., Taal, C. & Verspaget, W. (2004). *Demor—lcations based 3D audio game*. Blendind. http://blendid.nl/index8803.html

Collins, K. (2013). *Playing with sound: A theory of interacting with sound and music in video games*. The MIT Press.

Csikszentmihalyi, M. (2008). *Flow: The psychology of optimal experience* (1st ed.). HarperCollins e-books. https://www.amazon.com/Flow-Psychology-Experience-Perennial-Classics-ebook/dp/B000W94FE6

Cunningham, A. (2013, July 15). *The NES turns 30: How it began, worked, and saved an industry*. Ars Technica. https://arstechnica.com/gaming/2013/07/time-to-feel-old-inside-the-nes-on-its-30th-birthday/

Daglow, D. L. & Ismail, R. (2018). *Indie games: From dream to delivery* (1st ed.). Sausalito Media LLC.

Damoulakis, A. (2008). A blind man's take on interactive fiction. *Society for the Promotion of Adventure Games*, *52*. http://www.spagmag.org/archives/backissues/spag52_plain.html#blind

Darbellay, F. (2016). From disciplinarity to postdisciplinarity: Tourism studies dedisciplined. *Tourism Analysis*, *21*(4), 363–372. https://doi.org/10.3727/108354216X14600320851659

Davis, J. H., Allen, M. R. & Hayes, H. D. (2010). *Is blood thicker than water? A study of stewardship perceptions in family business* (SSRN Scholarly Paper ID 1709692). Social Science Research Network. https://doi.org/10.1111/j.1540-6520.2010.00415.x

Dewey, J. (1984). *The later works, 1925-1953*. SIU Press.

Dictionary.com. (n.d.-a). *Definition of independent*. Dictionary.com. https://www.dictionary.com/browse/independent

Dictionary.com. (n.d.-b). *Definition of indie*. Dictionary.com. https://www.dictionary.com/browse/indie

Dougherty, D. (2012). The maker movement. *Innovations: Technology, Governance, Globalization*, *7*(3), 11–14. https://econpapers.repec.org/article/tprinntgg/v_3a7_3ay_3a2012_3ai_3a3_3ap_3a11-14.htm

Dreskin, J. (2015). *A practical guide to indie game marketing* (1st ed.). Routledge.

Drewes, T. M., Mynatt, E. D., Gandy, M. & G, E. D. M. M. (2000). Sleuth: An audio experience. In *Proc. ICAD 2000*. https://www.academia.edu/13204104/Sleuth_An_audio_experience

Drossos, K., Zormpas, N., Giannakopoulos, G. & Floros, A. (2015). Accessible games for blind children, empowered by binaural sound. In *Proceedings of the 8th ACM International Conference on PErvasive Technologies Related to Assistive Environments* (pp. 1–8). https://doi.org/10.1145/2769493.2769546

Dursun, Y. (2007). The Onto-theological Origin of Play: Heraclitus and Plato. *Lingua ac Communitas, 17* (October), 69–78. http://lingua.amu.edu.pl/Lingua_17/lin-6.pdf

Dweyer, P. & VanLund, P. (2004a). *RPG game engine and map maker*. http://www.cs.unc.edu/Research/assist/et/projects/RPG/

Dweyer, P. & VanLund, P. (2004b). *The last crusade*. http://www.cs.unc.edu/Research/assist/et/projects/RPG/TheLastCrusade.htm

Edwards, O. (2006). The not-so-simple Simon proved the young were swifter than the old. *Smithsonian Magazine*. https://www.smithsonianmag.com/smithsonian-institution/not-so-simple-simon-proved-young-were-swifter-than-old-180953561/

Edwards, T. (2012, March 7). Kickstarter has raised an incredible amount of money for games: Numbers inside. *PC Gamer*. https://www.pcgamer.com/kickstarter-has-raised-an-incredible-amount-of-money-for-games-numbers-inside/

Eicher, J. P., Bearley, W. L. & Jones, J. E. (1999). *Post-heroic leadership: Managing the virtual organization*. Human Resource Development Press.

Evarts, H. (2018, March 7). *For blind gamers, equal access to racing video games*. Columbia Engineering. https://engineering.columbia.edu/press-releases/rad-blind-video-games

Fairbanks, B. (2017). *Lost and hound*. Game Jolt. https://gamejolt.com/games/lostandhound/281570

Fitzmaurice, L. (2019, April 8). 17 indie artists on their oddest odd jobs that pay the bills when music doesn't. *Vulture*. https://www.vulture.com/2019/04/how-indie-artists-actually-make-money-in-2019.html

Fizek, S., Woletz, J. & Beksa, J. (2015). Playing with sound and gesture in digital audio games. In A. Weisbecker, M. Burmester & A. Schmidt (Eds.), *Mensch und Computer 2015 - Workshopband* (pp. 423–429). https://doi.org/10.1515/9783110443905-061

Flying Mollusk LLC. (2015). *Nevermind*. Nevermind. https://nevermindgame.com

Franzen, C. (2014, July 1). The history of the Walkman: 35 years of iconic music players. *The Verge*. https://www.theverge.com/2014/7/1/5861062/sony-walkman-at-35

Friberg, J. & Gärdenfors, D. (2004). Audio games: New perspectives on game audio. In *Proceedings of the 2004 ACM SIGCHI International Conference on Advances in Computer Entertainment Technology* (pp. 148–154). https://doi.org/10.1145/1067343.1067361

Futter, M. & Bithell, M. (2017). *The GameDev business handbook: How to build the business you'll build games with*. Bithell Games.

Gadamer, H.-G. (1987). *The Relevance of the Beautiful and Other Essays*. Cambridge University Press.

Game Accessibility Guidelines. (n.d.). *Game accessibility guidelines. Full list*. http://gameaccessibilityguidelines.com/full-list/

Garcia, F. E. & de Almeida Neris, V. P. (2013). Design guidelines for audio games. In M. Kurosu (Ed.), *Human-computer interaction. Applications and services* (pp. 229–238). Springer. https://doi.org/10.1007/978-3-642-39262-7_26

Garda, M. B. & Grabarczyk, P. (2016). Is every indie game independent? Towards the concept of independent game. *Game Studies*, *16* (1). http://gamestudies.org/1601/articles/gardagrabarczyk

Gaudy, T., Natkin, S. & Archambault, D. (2009). Pyvox 2: An audio game accessible to visually impaired people playable without visual nor verbal instructions. In Z. Pan, A. D. Cheok, W. Müller & A. E. Rhalibi (Eds.), *Transactions on edutainment II* (pp. 176–186). Springer. https://doi.org/10.1007/978-3-642-03270-7_12

Gaver, W. W. (1986). Auditory icons: Using sound in computer interfaces. *Human-Computer Interaction*, *2* (2), 167–177. https://doi.org/10.1207/s15327051hci0202_3

Giannakopoulos, G., Tatlas, N.-A., Giannakopoulos, V., Floros, A. & Katsoulis, P. (2018). Accessible electronic games for blind children and young people. *British Journal of Educational Technology*, *49* (4), 608–619. https://doi.org/10.1111/bjet.12628

Glinert, E. & Wyse, L. (2007). AudiOdyssey: An accessible video game for both sighted and non-sighted gamers. In *Proceedings of the 2007 Conference on Future Play* (pp. 251–252). https://doi.org/10.1145/1328202.1328255

Google LLC. (n.d.-a). *Audio Game Hub—apps on Google Play*. https://play.google.com/store/apps/details?id=com.AUT.AudioGameHub&hl=en

Google LLC. (n.d.-b). *Get started on Android with TalkBack—Android accessibility help*. https://support.google.com/accessibility/android/answer/6283677?hl=en

Google LLC. (n.d.-c). *Make apps more accessible*. Android Developers. https://developer.android.com/guide/topics/ui/accessibility/apps

Gough, C. (2019). *U.S. computer and video game sales—digital vs. physical 2017*. Statista. https://www.statista.com/statistics/190225/digital-and-physical-game-sales-in-the-us-since-2009/

Grant, M. (2020). *What you should know about startups*. Investopedia. https://www.investopedia.com/terms/s/startup.asp

Gray, C. (1996). Inquiry through practice: Developing appropriate research strategies. In *Proceedings of No Guru, No Method? International Conference on Art and Design Research*. Conference on Art and Design Research, Helsinki, Finland. http://carolegray.net/Papers%20PDFs/ngnm.pdf

Grey, J. 'Catalyst'. (2014, May 26). *How blind gamers can play Skullgirls—Video shows tools those without sight can use to play this fighting game*. EventHubs. https://www.eventhubs.com/news/2014/may/26/how-blind-gamers-can-play-skullgirls-video-shows-tools-those-without-sight-can-use-play-fighting-game/

Griffin, J. (2014). *Leaderboards—The original and best social feature.* https://www.gamasutra.com/blogs/JohnGriffin/20140728/222026/Leaderboards_the_original_and_best_social_feature_.php

Hamilton, I. (2017). *The rapidly changing landscape of accessibility for blind gamers*. http://ian-hamilton.com/the-rapidly-changing-landscape-of-accessibility-for-blind-gamers/

Hamilton, J. (2011). The voices of the exegesis. In L. Justice & K. Friedman (Eds.), *Pre-conference proceedings of Practice, Knowledge, Vision: Doctoral Education in Design Conference* (pp. 340–343). The Hong Kong Polytechnic University. http://www.sd.polyu.edu.hk/DocEduDesign2011/

Hansen, P. B. (2013). *Classic operating systems: From batch processing to distributed systems* (2001 ed.). Springer.

Hatch, M. (2013). *The maker movement manifesto: Rules for innovation in the new world of crafters, hackers, and tinkerers* (1st ed.). McGraw-Hill Education.

Hermann, T. (2011). *The sonification handbook* (A. Hunt & J. G. Neuhoff, Eds.). Logos Verlag.

Hiles, D. (2001). *Heuristic inquiry and transpersonal research*. http://psy.dmu.ac.uk/drhiles/HIpaper.htm

Hill-Whittall, R. (2015). *The indie game developer handbook* (1st ed.). Routledge.

Huber, C., Röber, N., Hartmann, K. & Masuch, M. (2007). *Evolution of interactive audiobooks* [Paper presentation]. Audio Mostly - A Conference on Interaction with Sound. https://www.researchgate.net/publication/259308580_Evolution_of_Interactive_Audiobooks

Huey, J. & Sookdeo, R. (1994). The new post-heroic leadership. *Fortune Magazine*. https://archive.fortune.com/magazines/fortune/fortune_archive/1994/02/21/78995/index.htm

Hughes, D. (2013). *5 things we learned about developing an iOS game for blind players*. https://www.gamasutra.com/blogs/DianaHughes/20131120/205346/5_Things_We_Learned_About_Developing_An_iOS_Game_for_Blind_Players.php

Huizinga, J. (1949). *Homo Ludens: A study of the play element in culture*. London: Routledge & Kegan Paul. https://trove.nla.gov.au/version/43231152

IGDA GASIC. (2013). *IGDA GASIG blog: Kenji Eno (1970-2013)*. http://gameaccessibility.blogspot.com/2013/02/kenji-eno-1970-2013.html

IGDA GASIG. (n.d.-a). *About CVAA*. https://igda-gasig.org/what-and-why/about-cvaa/

IGDA GASIG. (n.d.-b). *For developers & researchers – IGDA game accessibility SIG*. https://igda-gasig.org/how/for-developers-researchers/

IGDA GASIG. (n.d.-c). *SIG guidelines – IGDA game accessibility SIG*. http://igda-gasig.org/get-involved/sig-initiatives/resources-for-game-developers/sig-guidelines/

Ings, W. (2011). Managing heuristics as a method of inquiry in autobiographical graphic design theses. *International Journal of Art & Design Education*, *30* (2), 226–241. https://doi.org/10.1111/j.1476-8070.2011.01699.x

Irwin, M. J. (2008). Indie game developers rise up. *Forbes*. https://www.forbes.com/2008/11/20/games-indie-developers-tech-ebiz-cx_mji_1120indiegames.html

ITR. (2019, April 11). It's an Easter egg, but not as you know it: The history of Easter eggs in media. *ITR*. https://www.itr.co.uk/2019/04/11/its-an-easter-egg-but-not-as-you-know-it-the-history-of-easter-eggs-in-media/

Janson, H. W. (1967). *History of art: A survey of the major visual arts from the dawn of history to the present day*. Prentice-Hall and Harry N. Abrams.

Jobs, S. (n.d.). *Steve Jobs—building a team of A players*. https://www.youtube.com/watch?v=wTgQ2PBiz-g

Jobst, K. (2020). *Blindfolded gaming is ridiculous*. https://www.youtube.com/watch?v=b_gAkRAqeDk

Johnson, J. (2015). *Future of immersive gaming gear for the blind*. https://phys.org/news/2015-09-future-immersive-gaming-gear.html

Juul, J. (2014). High-tech low-tech authenticity: The creation of independent style at the Independent Games Festival. In *Proceedings of the 9th International Conference on the Foundations of Digital Games*. Foundations of Digital Games. https://adk.elsevierpure.com/en/publications/high-tech-low-tech-authenticity-the-creation-of-independent-style

Juul, J. (2019). *Handmade pixels: Independent video games and the quest for authenticity*. The MIT Press.

Kane, S. K., Koushik, V. & Muehlbradt, A. (2018). Bonk: Accessible programming for accessible audio games. In *Proceedings of the 17th ACM Conference on Interaction Design and Children* (pp. 132–142). https://doi.org/10.1145/3202185.3202754

Kant, I. (2007). Critique of Judgement (N. Walker, Ed.; J. C. Meredith, Trans.). Oxford University Press.

Keane, B. (2013). *Marae protocol – te kawa o te marae*. Ministry for Culture and Heritage Te Manatu Taonga. https://teara.govt.nz/en/marae-protocol-te-kawa-o-te-marae

Keith, C. K. (2010). *Agile game development with SCRUM* (1st ed.). Addison-Wesley Professional.

Kelly, K. & Rheingold, H. (1993, March 1). The dragon ate my homework. *Wired*. https://www.wired.com/1993/03/muds-2/

Kim, S., Lee, K. & Nam, T.-J. (2016). Sonic-Badminton: Audio-augmented badminton game for blind people. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (pp. 1922–1929). https://doi.org/10.1145/2851581.2892510

Kinsela, B. (2019, October 1). *Amazon Alexa has 100k skills but momentum slows globally. Here is the breakdown by country.* Voicebot.Ai. https://voicebot.ai/2019/10/01/amazon-alexa-has-100k-skills-but-momentum-slows-globally-here-is-the-breakdown-by-country/

Klango. (2006, May 15). *Klango—Environment for developing and running of audio games and applications, software dedicated to blind and visually impaired people*. https://web.archive.org/web/20060713004022/http://www.klango.pl/en/info.php

Kleining, G. & Witt, H. (2000). The qualitative heuristic approach: A methodology for discovery in psychology and the social sciences. Rediscovering the method of introspection as an example. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, *1*(1), Article 1. https://doi.org/10.17169/fqs-1.1.1123

Knight, D. (2014, April 26). *Personal computer history: 1975-1984*. Low End Mac. https://lowendmac.com/2014/personal-computer-history-the-first-25-years/

Knight, D. (2015, December 12). *A history of Atari's 8-bit personal computers*. Low End Mac. https://lowendmac.com/2015/a-history-of-ataris-8-bit-personal-computers/

Kołyszko, M. (2011). Wiadomości prosto z 'Serca Zimy'. *Masz Wybór*. http://masz-wybor.com.pl/wiadomosci-prosto-z-serca-zimy/

Kroll, J. (2004). *The exegesis and the gentle reader/writer*. https://dspace.flinders.edu.au/xmlui/handle/2328/14076

Kumar, V. (2014, May 1). Making "freemium" work. *Harvard Business Review*. https://hbr.org/2014/05/making-freemium-work

Latorre, Ó. (2016). Indie or mainstream? Tensions and nuances between the alternative and the mainstream in indie games. *Anàlisi*, 15. https://doi.org/10.7238/a.v0i54.2818

Lazar, J., Goldstein, D. F. & Taylor, A. (2015). *Ensuring digital accessibility through process and policy* (1st ed.). Morgan Kaufmann.

Lee, H., Moon, M., Park, T., Hwang, I., Lee, U. & Song, J. (2013). Dungeons & swimmers: Designing an interactive exergame for swimming. In *Proceedings of the 2013 ACM Conference on Pervasive and Ubiquitous Computing Adjunct Publication* (pp. 287–290). https://doi.org/10.1145/2494091.2494180

Liljedahl, M., Papworth, N. & Lindberg, S. (2007). Beowulf: An audio mostly game. In *Proceedings of the International Conference on Advances in Computer Entertainment Technology* (pp. 200–203). https://doi.org/10.1145/1255047.1255088

Lipkin, N. (2013). Examining indie's independence: The Meaning of 'indie' games, the politics of production, and mainstream cooptation. *Loading...*, *7*(11), Article 11. http://journals.sfu.ca/loading/index.php/loading/article/view/122

Lisefski, B. (2019). *Why designers need to be 'specialized generalists'*. Medium. https://modus.medium.com/why-designers-need-to-be-specialized-generalists-520b020ec039

Lopatovska, I., Rink, K., Knight, I., Raines, K., Cosenza, K., Williams, H., Sorsche, P., Hirsch, D., Li, Q. & Martinez, A. (2018). Talk to me: Exploring user interactions with the Amazon Alexa: *Journal of Librarianship and Information Science*. https://doi.org/10.1177/0961000618759414

Lumb, D. (2018). *How a blind 'Call of Duty' player is racking up thousands of kills*. Engadget. https://www.engadget.com/2018-08-02-blind-call-of-duty-player-thousands-of-kills.html

Lumbreras, M. & Sánchez, J. (1999). Interactive 3D sound hyperstories for blind children. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 318–325). https://doi.org/10.1145/302979.303101

Lush, M. (2019, May 6). The leadership versus management debate: What's the difference? *IMNZ*. https://www.imnz.co.nz/the-leadership-versus-management-debate/

Lyons, K., Gandy, M. & Starner, T. (2000). *Guided by voices: An audio augmented reality system*. https://www.researchgate.net/publication/2487353_Guided_by_Voices_An_Audio_Augmented_Reality_System

Madigan, J. (2016, July 4). Why do achievements, trophies, and badges work? *The Psychology of Video Games*. http://www.psychologyofgames.com/2016/07/why-do-achievements-trophies-and-badges-work/

Mäkelä, M. & O'Riley, T. (2012). *The art of research II: Process, results and contribution*. Aalto University. https://aaltodoc.aalto.fi:443/handle/123456789/25246

Makuch, E. (2012). Minecraft creator says he's no longer indie. *GameSpot*. https://www.gamespot.com/articles/minecraft-creator-says-hes-no-longer-indie/1100-6349139/

Matsuo, M., Miura, T., Sakajiri, M., Onishi, J. & Ono, T. (2016). Audible Mapper & ShadowRine: Development of map editor using only sound in accessible game for blind users, and accessible action RPG for visually impaired gamers. In K. Miesenberger, C. Bühler & P. Penaz (Eds.), *Computers helping people with special needs* (pp. 537–544). Springer International Publishing. https://doi.org/10.1007/978-3-319-41264-1_73

Mccrindle, R. J. & Symons, D. (2000). Audio space invaders. In *Proceedings of the Third International Conference on Disability, Virtual Reality and Associated Technologies* (pp. 59–65). https://doi.org/10.1.1.104.4373

Mead, H. M. & Mead, S. M. (2003). *Tikanga Māori: Living by Māori Values*. Huia Publishers.

Menard, M. (2011). *Game Development with unity* (1st ed.). Cengage Learning PTR.

Mendels, P. & Frens, J. (2008). The audio adventurer: Design of a portable audio adventure game. In P. Markopoulos, B. de Ruyter, W. IJsselsteijn & D. Rowland (Eds.), *Fun and games* (pp. 46–58). Springer. https://doi.org/10.1007/978-3-540-88322-7_5

Merriam-Webster. (n.d.). *Definition of crowdfunding*. https://www.merriam-webster.com/dictionary/crowdfunding

Michael, D. (2003). *Indie game development survival guide* (1st ed.). Charles River Media.

Miller, D., Parecki, A. & Douglas, S. A. (2007). Finger dance: A sound game for blind people. In *Proceedings of the 9th International ACM SIGACCESS Conference on Computers and Accessibility* (pp. 253–254). https://doi.org/10.1145/1296843.1296898

Milne, L. R., Bennett, C. L., Ladner, R. E. & Azenkot, S. (2014). BraillePlay: Educational smartphone games for blind children. In *Proceedings of the 16th International ACM SIGACCESS Conference on Computers & Accessibility* (pp. 137–144). https://doi.org/10.1145/2661334.2661377

ModyGames. *MobyGames: Game Browser*. (2020). https://www.mobygames.com/browse/games/list-games/

Mojang. (2011). *Minecraft official site*. Minecraft.Net. https://www.minecraft.net/en-us/

Møller, H. (1992). Fundamentals of binaural technology. *Applied Acoustics*, *36*(3), 171–218. https://doi.org/10.1016/0003-682X(92)90046-U

Morelli, T., Foley, J., Columna, L., Lieberman, L. & Folmer, E. (2010). VI-Tennis: A vibrotactile/audio exergame for players who are visually impaired. In *Proceedings of the Fifth International Conference on the Foundations of Digital Games* (pp. 147–154). https://doi.org/10.1145/1822348.1822368

Morelli, T. & Folmer, E. (2011). Real-time sensory substitution to enable players who are blind to play video games using whole body gestures. In *Proceedings of the 6th International Conference on Foundations of Digital Games* (pp. 147–153). https://doi.org/10.1145/2159365.2159385

Moritz, A. & Block, J. (2016). *Crowdfunding: A literature review and research directions* (pp. 25–53). https://doi.org/10.1007/978-3-319-18017-5_3

Moss, R. (2014, August 6). *Why game accessibility matters*. Polygon. https://www.polygon.com/features/2014/8/6/5886035/disabled-gamers-accessibility

Moustakas, N., Floros, A. & Kanellopoulos, N. (2009, October 1). *Eidola: An interactive augmented reality audio-game prototype* [Paper presentation]. Audio Engineering Society Convention 127. http://www.aes.org/e-lib/browse.cfm?elib=15067

Multikino. (2013). *Orange: Serce Zimy w Multikinie*. Multikino Vue. https://multikino.pl/news/orange-serce-zimy-w-multikinie

Musa, T. (2013). Meet the blind teenager, Ben Breen, who has cracked the video game world relying solely on sound. *Daily Mail*. https://www.dailymail.co.uk/sciencetech/article-2266516/Meet-blind-teenager-Ben-Breen-cracked-video-game-world-relying-solely-sound.html

NASA. (n.d.). *Doppler effect*. https://www.grc.nasa.gov/www/k-12/airplane/doppler.html

Nepia, P. M. (2012). *Te Kore–exploring the Māori concept of void* [Doctoral dissertation, Auckland University of Technology]. https://openrepository.aut.ac.nz/handle/10292/5480

Nesteriuk, S. (2018). Audiogames: Accessibility and inclusion in digital entertainment. In V. G. Duffy (Ed.), *Digital human modeling. Applications in health, safety, ergonomics, and risk management* (pp. 338–352). Springer International Publishing. https://link.springer.com/chapter/10.1007%2F978-3-319-91397-1_28

Nolen, J. (2019, February 1). *The origins of Easter eggs in video games*. Medium. https://medium.com/@jnolen_17506/the-origins-of-easter-eggs-in-video-games-5b944c916941

Norman, C. (n.d.). *Indie game entrepreneur*. https://www.stitcher.com/s?fid=402598

Onlinetonegenerator.com. (2011). *Online Tone Generator–A free and simple way to generate DTMF dial tones.* http://onlinetonegenerator.com/dtmf.html

Opensource.org. (n.d.). *Licenses & standards.* Open Source Initiative. https://opensource.org/licenses

Orange Labs. (2014). *1812: Serce Zimy*. Orange.pl. https://www.orange.pl/kid,4004077722,id,4004077817,title,1812-Serce-Zimy-,article.html

PangaeaPanga. (2015). *Super Mario World blindfolded in 23:14*. https://www.youtube.com/watch?v=Aj-Mf0ZVoGs

Papworth, N. (2010). iSpooks: An audio focused game design. In *Proceedings of the 5th Audio Mostly Conference: A Conference on Interaction with Sound* (pp. 1–8). https://doi.org/10.1145/1859799.1859810

Parker, L. (2013). A video game that you can't even see. *The New Yorker*. https://www.newyorker.com/tech/annals-of-technology/a-video-game-that-you-cant-even-see

Paterson, N., Naliuka, K., Jensen, S. K., Carrigy, T., Haahr, M. & Conway, F. (2010). Design, implementation and evaluation of audio for a location aware augmented reality game. In *Proceedings of the 3rd International Conference on Fun and Games* (pp. 149–156). https://doi.org/10.1145/1823818.1823835

Paul, A. (2019, May 1). *Alexa & the smart speaker revolution–A historical perspective essay*. Medium. https://medium.com/voice-tech-podcast/alexa-the-smart-speaker-revolution-a-historical-perspective-essay-94cf551bbec1

Perez, E. (2019). *The design of indie games, a different paradigm* [Doctoral dissertation, University of Bayreuth]. https://doi.org/10.15495/EPub_UBT_00004330

Planells, A. (2015). Video games and the crowdfunding ideology: From the gamer-buyer to the prosumer-investor. *Journal of Consumer Culture*, *17*. https://doi.org/10.1177/1469540515611200

Podkosova, I., Urbanek, M. & Kaufmann, H. (2016). A hybrid sound model for 3D audio games with real walking. In *Proceedings of the 29th International Conference on Computer Animation and Social Agents* (pp. 189–192). https://doi.org/10.1145/2915926.2915948

Polanyi, M. (1967). *The tacit dimension*. Anchor Books.

Polskie Radio. (2012). *Audiobook 'Serce Zimy 1812'—Wszystkie odcinki*. PolskieRadio.Pl. https://polskieradio.pl/art481_579458

Powell, J. (n.d.). *Indie game business. A podcast on Anchor*. https://anchor.fm/indiegamebusiness

Radziewicz, S. (2015, September 26). Gry wideo pobierane przez Polskie Radio, kartridże i satelity. *Spider's Web*. https://www.spidersweb.pl/2015/09/na-drodze-do-lte.html

Röber, N. & Masuch, M. (2004). *Interacting with sound: An interaction paradigm for virtual auditory worlds* [Paper presentation]. International Conference on Auditory Display. https://smartech.gatech.edu/handle/1853/50861

Röber, N., Huber, C., Hartmann, K., Feustel, M. & Masuch, M. (2006). Interactive audiobooks: Combining narratives with game elements. In S. Göbel, R. Malkewitz & I. Iurgel (Eds.), *Technologies for interactive digital storytelling and entertainment* (pp. 358–369). Springer. https://doi.org/10.1007/11944577_36

Röber, N. & Masuch, M. (2005a). Playing audio-only games a compendium of interacting with virtual, auditory worlds. In *DiGRA '05 - Proceedings of the 2005 DiGRA International Conference: Changing Views: Worlds in Play*. http://www.digra.org/wp-content/uploads/digital-library/06276.30120.pdf

Röber, N. & Masuch, M. (2005b). *Leaving the screen: New perspectives in audio-only gaming*. https://smartech.gatech.edu/handle/1853/50168

Roden, T. E., Parberry, I. & Ducrest, D. (2007). Toward mobile entertainment: A paradigm for narrative-based audio only games. *Science of Computer Programming*, *67*(1), 76–90. https://doi.org/10.1016/j.scico.2006.07.004

Roschelle, J. & Teasley, S. D. (1995). The construction of shared knowledge in collaborative problem solving. In C. O'Malley (Ed.), *Computer supported collaborative learning* (pp. 69–97). Springer. https://doi.org/10.1007/978-3-642-85098-1_5

Rosenberg, L. & Brave, S. (1996). Using force feedback to enhance human performance in graphical user interfaces. In *Conference Companion on Human Factors in Computing Systems* (pp. 291–292). https://doi.org/10.1145/257089.257327

Rovithis, E. (2012). A classification of audio-based games in terms of sonic gameplay and the introduction of the audio-role-playing-game: Kronos. In *Proceedings of the 7th Audio Mostly Conference: A Conference on Interaction with Sound* (pp. 160–164). https://doi.org/10.1145/2371456.2371483

Rovithis, E., Floros, A., Mniestris, A. & Grigoriou, N. (2014). Audio games as educational tools: Design principles and examples. In *2014 IEEE Games Media Entertainment* (pp. 1–8). https://doi.org/10.1109/GEM.2014.7048083

Rovithis, E., Moustakas, N., Floros, A. & Vogklis, K. (2019). Audio legends: Investigating sonic interaction in an augmented reality audio game. *Multimodal Technologies and Interaction*, *3*(4), 73. https://doi.org/10.3390/mti3040073

Ruffino, P. (2013). Narratives of independent production in video game culture. *Loading...*, *7*(11), Article 11. http://journals.sfu.ca/loading/index.php/loading/article/view/120

Rutter, R., Lauke, P. H., Waddell, C., Thatcher, J., Henry, S. L., Lawson, B., Kirkpatrick, A., Heilmann, C., Burks, M. R., Regan, B. & Urban, M. (2006). *Web accessibility: Web standards and regulatory compliance*. Apress. https://doi.org/10.1007/978-1-4302-0188-5

Ryle, G. (1945). Knowing how and knowing that: The Presidential Address. *Proceedings of the Aristotelian Society*, *46*, 1–16. www.jstor.org/stable/4544405

Schön, D. A. (1984). *The reflective practitioner: How professionals think in action* (1 ed.). Basic Books.

Schreier, J. (2017). *Blood, sweat, and pixels: The triumphant, turbulent stories behind how video games are made*. Harper Paperbacks.

Schultz, W. (2018). *What is a AAA video game?* ThoughtCo. https://www.thoughtco.com/what-is-aaa-game-1393920

Schumann-Hengsteler, R. (1996). Children's and adults' visuospatial memory: The game concentration. *The Journal of Genetic Psychology*, *157*(1), 77–92. https://doi.org/10.1080/00221325.1996.9914847

Schwaber, K. & Beedle, M. (2001). *Agile software development with Scrum* (1 ed.). Pearson.

Schwarzl, T. (2014). *Game project completed: How successful indie game developers finish their projects* (1 ed.). Thomas Schwarzl.

Scrivener, S. (2000). Reflection in and on action and practice in creative-production doctoral projects in art and design. *Working Papers in Art & Design*, *1*. https://www.herts.ac.uk/__data/assets/pdf_file/0014/12281/WPIAAD_vol1_scrivener.pdf

Scrivener, S. (2010). Transformational practices: On the place of material novelty in artistic change. In M. Biggs & H. Karlsson (Eds.), *The Routledge companion to research in the arts* (pp. 259–276). Routledge. http://www.routledge.com/books/details/9780415581691/

Sela-Smith, S. (2002). Heuristic research: A review and critique of Moustakas's method. *Journal of Humanistic Psychology*. https://doi.org/10.1177/0022167802423004

Serban, S.-T. (2016). *Helios headgear uses Intel® RealSense™ technology to empower the visually impaired*. https://software.intel.com/en-us/articles/helios-headgear-uses-intel-realsense-technology-to-empower-the-visually-impaired

Shackleford, M. (2015). *Blackjack—wizard of odds*. https://wizardofodds.com/games/blackjack/basics/

Sharp, J. (2013, March 18). *Spacewar!, Punk pock, the indie dev scene and John Sharp*. Art, Media, & Technology. http://amt.parsons.edu/blog/spacewar-punk-rock-the-indie-dev-scene-and-john-sharp/

Shmilovici, U. (2011). The complete guide to freemium business models. *TechCrunch*. https://social.techcrunch.com/2011/09/04/complete-guide-freemium/

Sinek, S. (2009). *How great leaders inspire action*. https://www.ted.com/talks/simon_sinek_how_great_leaders_inspire_action

Soanes, C. & Stevenson, A. (Eds.). (2008). *Concise Oxford English dictionary: 11th edition revised 2008* (Rev. ed.). Oxford University Press.

Spencer, A. (2005). *DIY: The rise of Lo Fi culture* (Rev. ed.). Marion Boyars.

Stadler, V. & Hlavacs, H. (2018). *Blind adventure—A game engine for blind game designers*. In *CHI PLAY '18: Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play* (pp. 503–509). https://doi.org/10.1145/3242671.3242703

Su, X., Tong, H. & Ji, P. (2014). Activity recognition with smartphone sensors. *Tsinghua Science and Technology*, *19* (3), 235–249. https://doi.org/10.1109/TST.2014.6838194

Sumikawa, D. A. (1985). *Guidelines for the integration of audio cues into computer user interfaces* (UCRL-53656). Lawrence Livermore National Lab, CA. https://www.osti.gov/biblio/5475406

Summoning Salt. (2019). *The history of blindfolded punch-out*. https://www.youtube.com/watch?v=iZT6JEOC3D8

Swirsky, J. & Pajot, L. (2012). *Indie game: The movie (2012)*. BlinkWorks Media. http://www.imdb.com/title/tt1942884/

Szewczyk-Biedrzycka, A., Beksa, J. & Majewski, K. (2007). *Adventures of Jolan: Audio game usability tests*. Customer Testing Center, Polish Telecom.

Targett, S. & Fernström, M. (2003). *Audio games: Fun for all? All for fun*. https://www.researchgate.net/publication/228783230_Audio_games_Fun_for_all_All_for_fun

Taylor, P. (2009). *Text-to-speech synthesis*. Cambridge University Press. https://doi.org/10.1017/CBO9780511816338

Tiny Bull Studios. (2018). *Blind VR*. Fellow Traveller. https://fellowtraveller.games/games/blind/

TNW. (2016, March 24). *This engine is dominating the gaming industry right now*. The Next Web. https://thenextweb.com/gaming/2016/03/24/engine-dominating-gaming-industry-right-now/

Tomas, V. (1958). Creativity in art. *Philosophical Review*, *67*(1), 1–15. https://doi.org/10.2307/2182766

Tsakostas, C., Floros, A. & Deliyannis, I. (2007). Binaural rendering for enhanced 3D audio perception. In *Audio Mostly 2007 - 2nd Conference on Interaction with Sound, Conference Proceedings*. https://www.researchgate.net/publication/228632121_Binaural_Rendering_for_Enhanced_3D_Audio_Perception

Tyni, H. (2017). Double duty: Crowdfunding and the evolving game production network. *Games and Culture*. https://doi.org/10.1177/1555412017748108

Unity Technologies. (2017). *Make games - not tools: Value of 3rd-party engines. Unity whitepaper*. Unity. https://unity3d.com/whitepapers/adopting-unity

Urban Dictionary. (n.d.). *Indie games*. https://www.urbandictionary.com/define.php?term=indie%20games

Urbanek, M., Fikar, P. & Güldenpfennig, F. (2018). About the sound of bananas—Anti rules for audio game design. In *2018 IEEE 6th International Conference on Serious Games and Applications for Health (SeGAH)* (pp. 1–7). https://doi.org/10.1109/SeGAH.2018.8401361

Urbanek, M. & Güldenpfennig, F. (2019a). Celebrating 20 years of computer-based audio gaming. In *Proceedings of the 14th International Audio Mostly Conference: A Journey in Sound* (pp. 90–97). https://doi.org/10.1145/3356590.3356605

Urbanek, M. & Güldenpfennig, F. (2017). Tangible audio game development kit: Prototyping audio games with a tangible editor. In *Proceedings of the Eleventh International Conference on Tangible, Embedded, and Embodied Interaction* (pp. 473–479). https://doi.org/10.1145/3024969.3025077

Urbanek, M. & Güldenpfennig, F. (2019b). Unpacking the audio game experience: Lessons learned from game veterans. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play* (pp. 253–264). https://doi.org/10.1145/3311350.3347182

Urbanek, M., Güldenpfennig, F. & Habiger, M. (2019). Creating audio games online with a browser-based editor. In *Proceedings of the 14th International Audio Mostly Conference: A Journey in Sound* (pp. 272–276). https://doi.org/10.1145/3356590.3356636

Urbanek, M., Güldenpfennig, F. & Schrempf, M. T. (2018). Building a community of audio game designers—towards an online audio game editor. In *Proceedings of the 2018 ACM Conference Companion Publication on Designing Interactive Systems* (pp. 171–175). https://doi.org/10.1145/3197391.3205431

Valentine, R. (2018). *Developers weigh in on 'cold reality' check for indies*. GamesIndustry.Biz. https://www.gamesindustry.biz/articles/2018-10-03-developers-weigh-in-on-indie-discouragement

Velleman, E., van Tol, R., Huiberts, S. & Verwey, H. (2004). 3D shooting games, multimodal games, sound games and more working examples of the future of games for the blind. In K. Miesenberger, J. Klaus, W. L. Zagler & D. Burger (Eds.), *Computers helping people with special needs* (pp. 257–263). Springer. https://doi.org/10.1007/978-3-540-27817-7_39

Ventling, D. (2018). Heuristics—a framework to clarify practiceled research. *Heurística: DAT Journal*, *3*(2), 122–156. https://doi.org/10.29147/dat.v3i2.88

Ventling, F. D. (2017). *Illuminativa—The resonance of the unseen* [Doctoral dissertation, Auckland University of Technology]. https://openrepository.aut.ac.nz/handle/10292/10414

Virtue, G. (2016, June 13). How we made Bop It! *The Guardian*. https://www.theguardian.com/culture/2016/jun/13/how-we-made-bop-it-childrens-games-design

W3C. (2004). *Voice Extensible Markup Language (VoiceXML) Version 2.0*. https://www.w3.org/TR/2004/REC-voicexml20-20040316/

W3C. (2008). *Web Content Accessibility Guidelines (WCAG) 2.0*. https://www.w3.org/TR/WCAG20/

Walton, T. (2017, September 1). The overall listening experience of binaural audio. In *Procedings of 4th International Conference on Spatial Audio (ICSA)*. https://www.researchgate.net/publication/319402369_The_overall_listening_experience_of_binaural_audio

Wasilewska-Śpioch, A. (2008). *TP organizuje konkurs na fabułę gry RPG - aktualizacja*. Dziennik Internautów. http://di.com.pl/tp-organizuje-konkurs-na-fabule-gry-rpg-aktualizacja-23423

WBU. (2017). *WBU statement for World Sight Day 12 October 2017*. http://www.worldblindunion.org/English/news/Pages/WBU-Statement-for-World-Sight-Day-12-October-2017.aspx

Webber, J. E. (2014, October 13). Video games which open the door for the blind to play. *The Observer*. https://www.theguardian.com/technology/2014/oct/13/video-games-that-let-blind-people-play

Welch, B. (2019, January 20). This blind gamer totally rules at Mortal Kombat. *Vice*. https://www.vice.com/en_us/article/j57egb/this-blind-gamer-totally-rules-at-mortal-kombat

Westin, T. (2004). *Game accessibility case study: Terraformers - a real-time 3D graphic game*. http://urn.kb.se/resolve?urn=urn:nbn:se:su:diva-38445

Whidden, D.L., III (2016). The Theology of Play and the Play of Theology in Thomas Aquinas. The Thomist: A Speculative Quarterly Review 80 (2), 273-284. https://doi.org/10.1353/tho.2016.0015

Wiggers, K. (2020, February 13). Strategy analytics: Google and Amazon ceded smart speaker market share to Chinese rivals in 2019. *VentureBeat*. https://venturebeat.com/2020/02/13/google-and-amazon-ceded-smart-speaker-market-share-to-chinese-rivals-in-2019/

Woletz, J. (2015). *Audio Game Hub user experience test*. Media Uselab, Centre for Digidal Cultures, Leuphana Universität Lüneburg. https://www.slideshare.net/juliewoletz/media-uselab-studienauswahl

World Health Organization. (2019). *Vision impairment and blindness*. https://www.who.int/news-room/fact-sheets/detail/blindness-and-visual-impairment

Wright, J. T., Embrick, D. G. & Henke, K. (2015). Interdisciplinarity, post-disciplinarity, and anomic specialization: Where do we locate sociology? *Humanity & Society*, *39*(3), 267–273. https://doi.org/10.1177/0160597615593233

Wu, W. & Rank, S. (2015). Audio feedback design principles for hand gestures in audio-only games. In *Proceedings of the Audio Mostly 2015 on Interaction With Sound* (1–6). https://doi.org/10.1145/2814895.2814925

Xian-Yi, C. & Yan, P. (2011). Review of modern speech synthesis. In W. Hu (Ed.), *Electronics and signal processing* (pp. 517–524). Springer. https://doi.org/10.1007/978-3-642-21697-8_65

Yin-Poole, W. (2016, January 4). Blind gamer completes The Legend of Zelda: Ocarina of Time. *Eurogamer*. https://www.eurogamer.net/articles/2016-01-04-blind-gamer-completes-the-legend-of-zelda-ocarina-of-time

Yu, D. & Deng, L. (2015). *Automatic speech recognition: A deep learning approach*. Springer-Verlag. https://doi.org/10.1007/978-1-4471-5779-3

Yuan, B. & Folmer, E. (2008). Blind hero: Enabling guitar hero for the visually impaired. In *Proceedings of the 10th International ACM SIGACCESS Conference on Computers and Accessibility* (pp. 169–176). https://doi.org/10.1145/1414471.1414503

Yuan, B., Folmer, E. & Harris, F. C. (2011). Game accessibility: A survey. *Universal Access in the Information Society*, *10*(1), 81–100. https://doi.org/10.1007/s10209-010-0189-5

Zimmerman, E. (2002). *Do independent games exist?* http://www.ericzimmerman.com/s/indiegames.pdf

Zolotaryov, D. (2016, November 20). *How to motivate and retain programmers*. Medium. https://medium.com/@dimitryz/how-to-retain-and-motivate-programmers-9bec6cf7ae54

Appendices

The thesis's appendices contain seven files that interface with the discussions within the exegetical text:

- Appendix A – *Audio Game Hub* prototype usability study results,
- Appendix B – *Audio Game Hub* examples of games flow design,
- Appendix C – Crowdfunding workshop report,
- Appendix D – *Audio Game Hub* and *Blind Cricket* user feedback,
- Appendix E – *Audio Game Hub* and *Blind Cricket* results,
- Appendix F – *Audio Game Hub* and *Blind Cricket* change log,
- Appendix G – *Audio Game Hub* and *Blind Cricket* credits,
- Appendix H – Individual team members' contributions.

Appendix A – *Audio Game Hub* prototype usability study results

This section outlines the *Audio Game Hub* prototype usability study results conducted by Woletz (2015)[243] and published by Fizek et al. (2015).[244] These results preceded my embarkation on the thesis, but the data was a useful resource as I refined and developed games within the project. This summary comes from that document.

The instigating *Audio Game Hub* prototype was developed at the Gamification Lab at Leuphana University in Lüneburg, Germany. Early experiments were introduced to and tested on two separate groups of sighted gamers and one group of visually impaired players. Group one comprised 12 heavy gamers who played for at least four hours per week on different devices. Group two comprised 12 casual gamers who played for a maximum of three hours per week, predominantly on mobile devices. The third group comprised five visually impaired players with gaming experience. A total of 29 participants ranging from 19 to 52 years of age tested the *Audio Game Hub* during individual face-to-face interviews of 60 minutes duration.

To gain insights into the various players' needs and interests, the participants played in different modes:

- Group one – 12 heavy gamers: one half of the group played with visual aids switched on, the other half played with the visual mode switched off
- Group two – 12 casual gamers: one half of the group played with visual aids switched on, the other half played with the visual mode switched off
- Group three – five visually impaired persons played without being able to see the screen at all.

The main goal of the testing was to identify usability problems with this relatively new kind of audio interface and interactive sounds, and to evaluate how well the different types of interaction and gameplay mechanics fitted the needs and interests of the various groups of gamers. Further, the overall user experience of each game in the *Audio Game Hub* was evaluated. During the 60-minute test interviews, participants were observed while playing and were able to provide detailed feedback regarding the quality of the spoken

[243] https://www.slideshare.net/juliewoletz/media-uselab-studienauswahl.
[244] https://rke.abertay.ac.uk/en/publications/playing-with-sound-and-gesture-in-digital-audio-games.

explanations and sound clues, the attractiveness of in-game character voices and ambient sounds, as well as the perceived immersion and joy-of-use of each game.

Test results revealed that the majority of sighted gamers preferred playing the games with the visual mode off and enjoyed the unusual audio-only gaming experience. To continue playing, heavy gamers expected additional levels with increasing difficulty, which were not implemented in the *Audio Game Hub* at this stage. Although some usability aspects still required improvement, visually impaired gamers found their needs and interests well met and praised the perceived joy-of-use.

The testing also showed that sound-centred gameplay mechanics, such as acoustic orientation in *Labyrinth*, aiming with sound clues in *Archery*, or using sound memory in *Animal Farm*, were perceived as challenging, especially by sighted players, yet they received the best feedback. All user groups stressed the importance of good ambient sounds and voice design and its positive influence on the overall gaming experience.

For a more in-depth analysis of the context and outcomes of this research, see:

Woletz, J. (2015). *Audio Game Hub user experience test*. Media Uselab, Centre for Digidal Cultures, Leuphana Universität Lüneburg. https://www.slideshare.net/juliewoletz/media-uselab-studienauswahl

Fizek, S., Woletz, J. & Beksa, J. (2015). Playing with sound and gesture in digital audio games. In A. Weisbecker, M. Burmester & A. Schmidt (Eds.), *Mensch und Computer 2015 - Workshopband* (pp. 423–429). https://doi.org/10.1515/9783110443905-061

Appendix B – *Audio Game Hub* examples of games flow design

This section provides digital renderings of three *Audio Game Hub* games flow created in Microsoft PowerPoint (see Figures B.1 to B.3). These visualisations are referred to in Section 4.4.

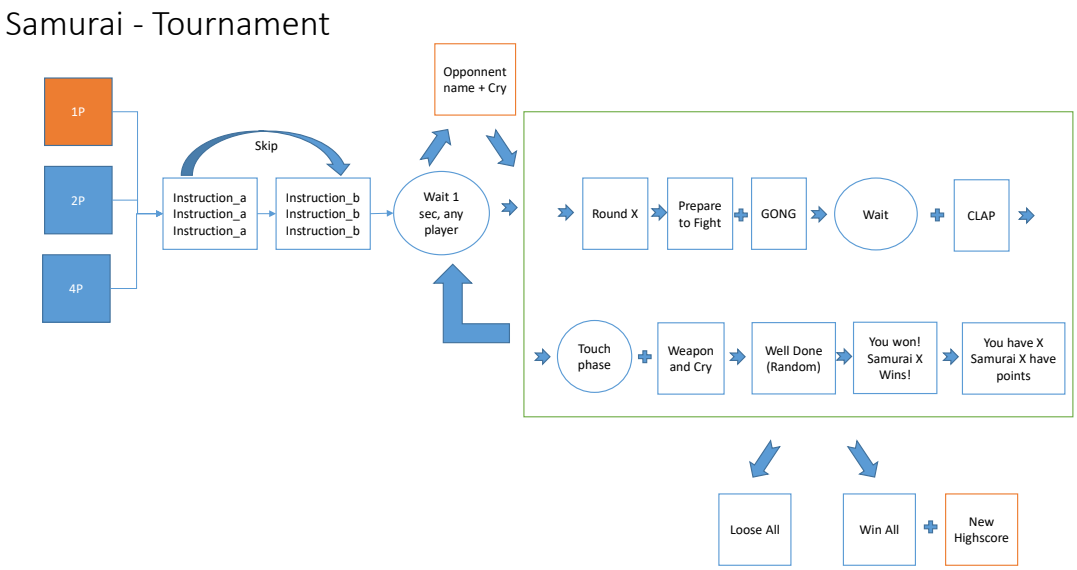


Figure B.1. Example of digital rendering of *Samurai Tournament* game flow. © Jarosław Beksa.

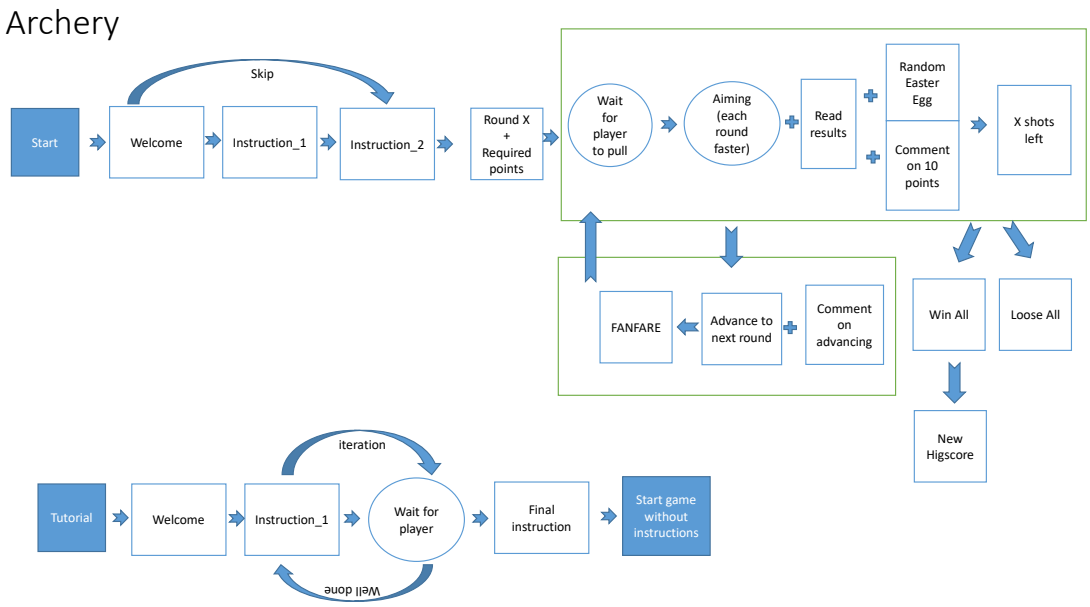


Figure B.2. Example of digital rendering of *Archery* game flow. © Jarosław Beksa.

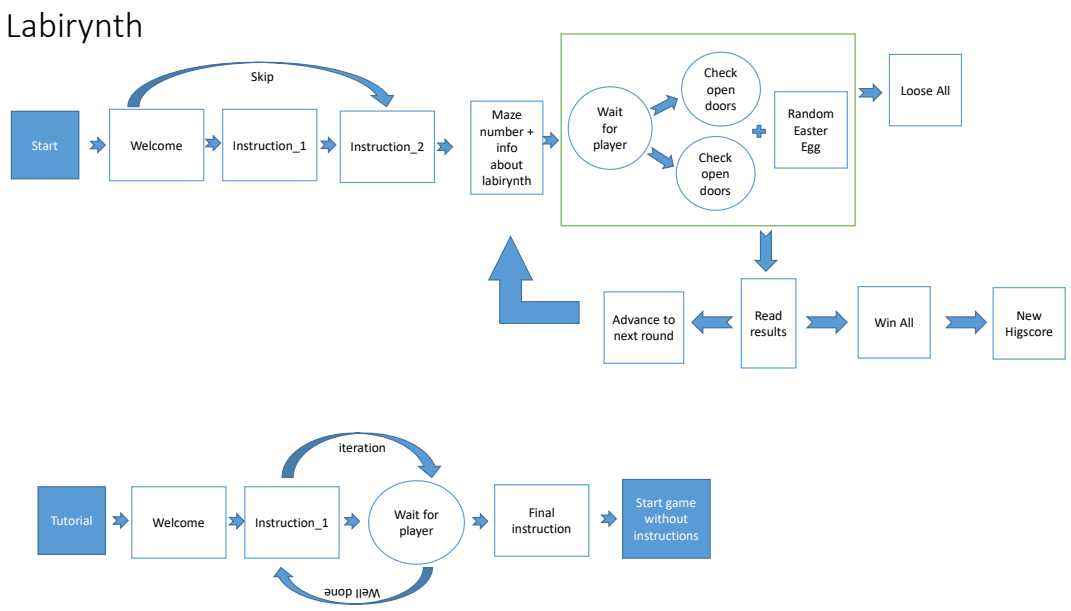


Figure B.3. Example of digital rendering of *Labyrinth* game flow. © Jarosław Beksa.

Appendix C – Crowdfunding workshop report

This section presents a detailed crowdfunding workshop report containing the communication plan and campaign strategy for the *Audio Game Hub* Kickstarter campaign. This report is referred to in Section 5.2.2. It is included as an appendix because it may be useful for other Indie Designers/Developers considering this form of funding.

Date:	10 October 2016
Report prepared by:	Kat Jenkins
On behalf of:	Audio Game Hub / Jarek Beksa
Planned project dates:	November / February
Seeking:	$5,000 through rewards crowdfunding
Recommended platform:	Kickstarter

Project overview

Audio Game Hub is an app that is currently available in both iOS and Android devices. It is a collection of games that can be played by visually impaired people. Currently, the app supports 8 games. The crowdfunding campaign will allow the team to develop 5 new games for the app, including one game that will be exclusively for Kickstarter backers.

An additional goal of raising $50,000 to make the app "free forever" will be applied to this campaign.

Current crowd

Audio Game Hub is an existing app with a current userbase of around 20,000 downloads. The app has a high user rating (4.8 on Google Play) and 70% of users are active.

The app is currently free on Google Play and the App Store.

The company have received requests from users to add more games. The current userbase can be activated to a Kickstarter campaign through a push-notification to users.

This game caters especially to the visually impaired as it relies on audio cues more than visual ones. It has been endorsed by the New Zealand's Blind Low Vision NZ.

Numbers

Audio Game Hub Users (active)	14,000
Blind Low Vision NZ	Facebook: 7,402
	Mailing list: Unknown
Audio Game Hub	Facebook: 95
	Twitter: 52
	Mailing list: Unknown

Project audience(s) and motivations

Knowing your audience is the first key to successful marketing. It's recommended the creators work through the 'Ideal Backer' exercise for project to further flesh out these ideas.

Knowing who your 'Ideal Backer' is helps target marketing activities to have the most impact.

For Audio Game Hub, the audience is international, with particular focus on Australia, UK, America, and New Zealand:

- Blind and visually impaired people
- People needing extra accessibility in order to participate in games
- Teachers, support people, and parents of blind and visually impaired people.

Pitch and key messages

It's important to pitch to your ideal backer. Think about how the product will benefit the end user, and rather than selling the product, sell the bigger picture behind it.

What does your product do better than anyone else? How will it help reduce pain, stress, and problems in your backer's lives? By doing the 'Ideal Backer' exercise, you will have a better understanding of how Audio Game Hub can be sold to that person.

Each product will need an individually crafted pitch that will inform the campaign messaging through video, description, rewards and updates.

If a PR agency is engaged, they may help further develop your pitch ideas.

Audio Game Hub

Existing users of Audio Game Hub will probably want more games, and could be enticed to purchase them through a crowdfunding campaign without a lot of extra information.

Crowd-participation activities like 'vote for the games we make' can be harnessed to help create a sense of connection between creator and backer.

The main message of the overall campaign should probably be the benefit to blind and visually impaired people as this is the main 'Ideal Backer' audience. Emphasising the currently-available app's ratings and user reviews will provide credibility to those hearing about Audio Game Hub for the first time.

PR and promotion

Weaknesses

While the current userbase of Audio Game Hub means $5,000 for that project is achievable, the $50,000 stretch goal is a much loftier goal needing at least 1,500 backers.

Crowdbuilding

The current user base of the Audio Game Hub app indicates that the campaign could fund its modest target of $5,000 without any major crowdbuilding.

Audio Game Hub is setting a stretch goal of $50,000 which would make the app free forever. To reach this goal, considerable relationship building should be aimed at:

- International blind support agencies - making contacts at foundations and support organisations in the US, UK, and Australia could add an extra 111,000 eyeballs to the campaign.
- AUT outlets - formalised support from AUT through social media and email promotion could add an extra 85,000 eyeballs.

- Gamer connections - several members of the Auckland Game Developers Meetup have run successful crowdfunding campaigns. They may be able to help develop connections to media, offer experience, and lend their crowd to the campaign.
- Social media focus - current social media outlets for both Audio Game Hub are effectively abandoned, with nothing posted since April/May 2016. It's recommended pages and Twitter accounts either be posted to regularly, or shut down. Placement of links on both websites should be easier to find.
- Email lists - It's noted that Audio Game Hub is actively collecting emails on its website. That lists should be activated and maximised, including the installation of a nurture sequence.
- Content marketing - both apps have interesting social and educational outcomes that could be explored by the founders posting on Medium.com and LinkedIn, and including links to email list signups and social media channels.
- Targeted influencers - blind activists and influencers; academics interested in accessibility, technology and literacy.
- The aim of crowdbuilding is to swell your influence. To do this, you need to make meaningful connections with users, key influencers, and agencies. These can aid amplification of your message to the target audience ('ideal backers') during your campaign, and further down the road into your business.

A list of 25 relevant websites and influencers to begin crowdbuilding efforts is provided alongside this report.

Further reading:

- The 5 Elements of Crowdfunding Promotion
- The Secret to Getting Exposure From Influencers
- 6 Science-Backed Strategies to Get More Followers on Twitter, Facebook, Instagram, and More
- Best Pitch I Ever Got - Carley Knobloch

Media

Traditional media and 'new media' can help amplify the messages of the campaign. For Audio Game Hub, it would help to partner with organisations that can help generate interests in the US, UK, and Australia.

A media kit including video footage would help increase chances of media coverage.

Pitch angles could include literacy, 'unique NZ tech', accessibility, or a combination of the 3. While asking for a link to the campaign is a good idea, pitching a crowdfunding campaign is generally not a good idea.

Building and maintaining relationships with appropriate journalists during the Audio Game Hub campaign could lead to effective coverage.

Suggested outlets for New Zealand-based media include:

- **Newspapers**: New Zealand Herald, Dominion Post/stuff.co.nz, local newspapers.
- **Radio**: Our Changing World (RadioNZ), Nine To Noon (RadioNZ).
- **TV**: NewsHub, TVNZ, Prime News, Paul Henry, Breakfast, Seven Sharp, Story.

'New media' can include podcasts, large Facebook pages such as 'Upworthy', and news/lifestyle websites such as The Huffington Post, Gizmodo, Buzzfeed etc. Reaching out and/or pitching articles to these organisations can result in increased crowd-size.

Further reading:

- How To Build A Press Kit
- How To Write And Send A Press Release
- 5 free and effective publicity tools to boost your crowdfunding campaign
- The Two-Step Method for Easy Press Coverage
- Best Pitch I Ever Got - Jeana Lee Tahnk

Personal networks

It's recommended that the team leverage their personal networks to send out a three stage appeal.

This involves:

- Collating email contacts for as many friends and family as possible.
- Separating those contacts into three categories:
    - Close contacts - people who know about the project and know you well.
    - Secondary contacts - may or may not know about the project, but know you.
    - Acquaintances - people who won't know about the project and may have only briefly met you, or who you haven't seen in a long time.
- Drafting a general email designed to get people to view the fundraising page for each group.

- Creating a personal message for each contact (you may choose to do this for only the first and/or second groups if you wish).
- Using a tool such as Mailchimp to automatically send out these links.

Full instructions on this process can be found here.

Budget

Crowdfunders often need to prioritise their funds leading up to a campaign. To that end, it's recommended that budget be prioritised towards the following:

PR/Promotion in relevant countries

The target audience for this project is multi-national and PR spend could be a good way to help make the goal. A good PR agency will:

- Work with you, including on the campaign pitch.
- Send individual pitches to an agreed number of outlets and follow up with the journalist.
- Have a history of working with technology, apps, accessibility/blind/visually impaired issues.
- Have connections to the outlets you wish to appear in.

Kat has had good experiences with Rhetoric PR in Australia and Pead PR in New Zealand.

Facebook management and ads

Management of the Facebook page will help increase the audience numbers, brand awareness and engagement. Crowdbuilding and engagement is critical to being able to reach large numbers in crowdfunding campaigns, and Facebook is one of the best places to find them.

The targeted nature of Facebook ads means that you can select your ideal backer - which when done right can have a huge ROI, particularly in the middle of a campaign.

There are numerous services available, and potentially in the AUT pool of marketing students. Kat has had a good experience with Jayne Day of Webonize.

Videographer

For campaigns seeking over $25,000, a professional videographer is a good investment. Kat recommends Benj Brooking in Auckland.

Feedback and guidance

It is worthwhile to browse Kat's resources to see if there is anything that can help with the campaign. All resources have explainer blogs and most are provided for free.

Prior to launching, Kat can offer two services:

- One-on-one Skype calls - to check in on progress, offer help and guidance, and provide feedback as the campaign page develops. ($99 for 30 minutes + follow up email)
- Campaign Review - a pre-launch check to ensure your campaign page is set to convert viewers to backers. ($149 for campaign review + 30 minute Skype call + follow up email)

Both services can be automatically scheduled and paid for online.

Draft communication strategy

Table C.1
Draft communication strategy for the Audio Game Hub Kickstarter campaign

Date	Audio Game Hub campaign
17-23 October	**Marketing** - Complete 'Ideal Backer' exercise and agree on pitch for campaign. **Campaign design** - Kickstarter account opened and project started. - Scripts and plans for the video finalised. - Copy for campaign drafted and input into campaign. - Media for campaign agreed. - Reward tier copy finalised and input into campaign. **Promotion** - Lists of journalists, target websites, influencers and publications complete. - Decision as to whether to use a PR agency made, and agencies contacted for initial consultations.
24-29 October	**Campaign design** - Film and edit final video. - Media finalised and input into campaign. - Draft campaign copy edited and finalised. **Promotion** - Hire PR agency and/or begin individual outreach to influencers, and target websites. - Compile lists of contacts for global blind agencies.
31 October - 6 November	**Campaign testing and tweaking** - Test campaign with 'ideal backers' and implement feedback. - If you wish feedback from Kat, this week is a good week to do it. **Promotion** - Compile personal email lists for team and set up Mailchimp mailout. - Finalise press release and outreach list. - Prepare push-notification. - Finalise copy to introduce the app to international blind agencies.

Date	Audio Game Hub campaign
7 November	**Launch day** Send personal emails to Groups 1 and 2. Ensure 2-3 hours space between each group. Send push-notification once the campaign is at 30%, or at the end of 12 hours - whichever comes first.
8 November	**Day Two** Send personal emails to Group 3. Begin approaching journalists if a PR agency is not involved in this campaign. Begin approaching international blind agencies. Send update to backers thanking them for support and asking for shares.
9 November	**Day Three** Resend emails to those in Groups 1 and 2 who did not open the first message with slightly reworded copy and a new subject line/sender name (personal names work best!) Follow up with influencers/websites you contacted earlier and update them on the campaign progress and any good feedback you've been receiving.
10-13 November	**Week One** Resend emails to those in Group 3 who did not open the first message with slightly reworded copy and a new subject line/sender name (personal names work best!) Follow up with media who you haven't heard from. Thank the media who have covered you. Backer update highlighting any coverage, and inviting shares.
14-20 November	**Week Two** Follow up with international blind agencies and media - thank for any links you've had. Backer update highlighting any support from international blind agencies and media. Announce stretch goal IF you have reached $10,000. Publish piece on Medium.com or LinkedIn looking at something to do with visually impaired access to gaming and the results Audio Game Lab achieves. Include link to campaign and announce stretch goal IF you have reached $10,000. Begin Facebook ad campaign.

Date	Audio Game Hub campaign
21-27 November	**Week Three** Send reminder emails to Groups 1, 2 and 3 - include stretch goal announcement if applicable. Final update to interested media, including stretch goal update. Email thanks and update to international blind agencies, and ask for support leading up to close of campaign. Include stretch goal if applicable. Backer updates - link to last week's article, ask for shares, reminder of stretch goal. Send push notification about the stretch goal. Continue Facebook ad campaign - update to stretch goal.
28-29 November	**Week Four** Update backers on progress, ask for shares. Begin asking for votes on which games to make. Send out second press release to NZ media about progress, support and stretch goals. Include links to any media you've got, and endorsements from international blind agencies. Continue Facebook ad campaign – 'last days'.
30 November	**48 Hours to Go** Send final reminder email to Groups 1, 2, and 3. Update backers on progress, ask for shares.
1 December	**After close** Update backers on totals, thank them for their support, let them know what happens from here. Ask for votes on which games to make. Final thank you to anyone who has been particularly supportive. Connect via LinkedIn/Facebook with anyone noteworthy you've met through the campaign.
2-4 December	Production mode - fulfilment of rewards. Close votes on which games to make.
5-11 December	Production mode - fulfilment of rewards. Post to Facebook about progress and which games will be made.
12-18 December	You should receive your funds this week. Send an update, wish everyone a Happy Holidays, include a happy team photo, encourage them to Facebook. Tell them which games will be made.
19-25 December	Production mode - fulfilment of rewards (or a Christmas Break).

Date	Audio Game Hub campaign
26 December - 1 January	Production mode - fulfilment of rewards (or a Christmas Break).
2-8 January	Production mode - fulfilment of rewards (or a Christmas Break).
9-15 January	Backer update - where are you, when will rewards be fulfilled?
16-22 January	Production mode - fulfilment of rewards. Backer surveys should go out about now. Update to notify about surveys.
23-29 January	Production mode - fulfilment of rewards. Update reminder about surveys.
30 January - 5 February	All rewards should be fulfilled this week. Backer update - let them know all rewards are fulfilled, how to contact you if theirs hasn't arrived. Migrate backer emails from Kickstarter to Mailchimp list.

Draft rewards structure

Table C.2
Draft rewards structure for the Audio Game Hub Kickstarter campaign

Cost	Reward
$5	**Supporter** [Approx US$X] You'll get regular updates on our progress, and the ability to vote for which games we release.
$20 (limited to 500)	**Special Edition Earlybird** [Approx US$XX] Get 4 brand new games PLUS an exclusive backers-only game. You'll also get regular updates on our progress, and the ability to vote for which games we release.
$25	**Special Edition** [Approx US$XX] Missed the earlybird? Grab the 4 new games PLUS an exclusive backers-only game. You'll also get regular updates on our progress, and the ability to vote for which games we release.

Cost	Reward
$50 (limited to 100)	**Early-bird box edition** [Approx US$XX] Get a USB box edition of the game sent to you. On your USB, you'll find the 8 current games, plus the 4 new games, PLUS the exclusive backers-only game. You'll also get regular updates on our progress, and the ability to vote for which games we release.
$75	**Box edition** [Approx US$XX] Missed the earlybird? Get a USB box edition of the game sent to you. On your USB, you'll find the 8 current games, plus the 4 new games, PLUS the exclusive backers-only game. You'll also get regular updates on our progress, and the ability to vote for which games we release.
$100 (limited to 100)	**Name in the credits** [Approx US$XX] Have your name in the game's credits to prove your support! AND get the USB box edition of the game sent to you. On your USB, you'll find the 8 current games, plus the 4 new games, PLUS the exclusive backers-only game. You'll also get regular updates on our progress, and the ability to vote for which games we release.
$500 (limited to 5)	**Special message in the credits** [Approx US$XXX] Put a special message in the game's credits with your name. Subject to content approval by the gamemaker. Plus get 2 USB box editions of the game sent to you. On each USB, you'll find the 8 current games, plus the 4 new games, AND the exclusive backers-only game. You'll also get regular updates on our progress, and the ability to vote for which games we release.
$2,500 (limited to 5)	**Be a character!** [Approx US$XXXX] We'll set up an appointment at a recording studio local to you and you can become a character in the game! You probably won't be a major character, but you'll be in there. You are responsible for travel to and any accommodation required for the recording. Plus get 5 USB box editions of the game sent to you. On each USB, you'll find the 8 current games, plus the 4 new games, AND the exclusive backers-only game. You'll also get regular updates on our progress, and the ability to vote for which games we release.

Cost	Reward
$5,000 (limited to 3)	**Featured logo** [Approx US$XXXX] Show your business' or organisation's support for Audio Game Hub and have your logo featured on screen alongside others whenever a user opens the app. Plus get 10 USB box editions of the game sent to you. On each USB, you'll find the 8 current games, plus the 4 new games, AND the exclusive backers-only game. You'll also get regular updates on our progress, and the ability to vote for which games we release.
$8,000	**Sponsor the game** [Approx US$XXXX] Show your business' or organisation's support for Audio Game Hub and have your logo featured on a single screen whenever a user opens the app. Plus get 25 USB box editions of the game sent to you. On each USB, you'll find the 8 current games, plus the 4 new games, AND the exclusive backers-only game. You'll also get regular updates on our progress, and the ability to vote for which games we release.

Appendix D – Audio Game Hub and Blind Cricket user feedback

This section presents *Audio Game Hub* and *Blind Cricket* user feedback collected from forum posts, reviews and emails. The appendix provides evidence for issues and claims discussed in the exegesis.

User feedback on audio game forums

This first section outlines the user feedback posted on the two most popular online forums for visually impaired gamers:

- Audiogames.net:
    - https://forum.audiogames.net/topic/18679/audiogame-hub-for-ios-has-been-released/
    - https://forum.audiogames.net/topic/22424/ios-audio-game-hub-20/
    - https://forum.audiogames.net/topic/21368/blind-cricket-for-android-and-ios/

- AppleVis:
    - https://www.applevis.com/apps/ios/games/audio-game-hub
    - https://www.applevis.com/forum/audio-game-hub-20-here
    - https://www.applevis.com/apps/ios/games/blind-cricket

Below is an extract of submitted posts related to *Audio Game Hub* version *1.0*, *2.0* and *Blind Cricket* (the total number exceeded 250). The reviews have been copied in their original form (including grammatical or spelling errors) and are publicly available online.

Extract of submitted forum posts on Audiogames.net forum

Audiogames.net forum posts
Aaron (Administrator) - 2016-04-24 I played through all of the games today, it's quite a nice app. The only bug I found was wih the tutorial, I could swipe right to move through the menu but then it asked me to double tap the screen and when I tried to double tap, nothing happened. I kept on dobule tapping and it eventually took me to the main menu.
SLJ - 2016-04-26 Hi. Wow, I really like this collection of games. Some are better than others. I really like that you can play multiplayer locally. I'm wandering why they aren't using gamecenter instead of their own score system, which doesn't seem to work? It is really fantastic that the game also have graphics. Wow I'm impressed. The sounds and the voice acting is really great.
Sneak - 2016-04-25 I managed to beat all of the games last night, except for blocks, I don't think that one can be beaten. Pretty nifty. I also managed to score over 100000 coins in the casino too LOL. I can't seem to access the high scores page, it says it's going to redirect me, but it just loaded an empty page.
Hanif - 2016-04-26 I've tried it on iOS and have beatten most of the game, except archery, memory and blocks. for the archery game, I only managed to get to round 11, and in the memory game I got to the final shipment but it's too long to me to memorize all of the boxes and the result is the timer runs out and the animal farmer have to pair the animals himself. as for samurai game, I aggree with aaron, it's really disappointing. when I first start the samurai game, I'm thinking that this one will be a good fighting game. but, then, it's just only a reaction test game. but overall, this one is a really cool game.
Jack - 2017-07-13 Socheat, the free part can be best called adware in a sense that you can play for free but need to watch advertisements and, unfortunately, turn on voiceover/talkback to find the close button since they don't really automatically close. I just went ahead and bought them without question.
SLJ - 2017-07-13 Hi. I just spent a lot of time on the new game while traveling by train. First a bit about what I don't like: What is the difference between the Simon game and the bomb game? When playing the tutorial, those games seem very much simuler. I'm not a music composer or anything like that, and I find it difficult to hear the difference between the 4 tones. They sounds like when pressing the numbers on a phone. More standard beep tones would be much better to hear the difference in my opinion. Now to the things I like: The new blackjack game is pretty awesome. Very easy to play, but something which I could see myself keep playing again and again. All the achievements and scoreboards, just wow... Thanks a lot for all that. I'm not the kind of gamer who choose to spent all my life constantly being the best on scoreboards, but it's very nice it's there, and getting achievements is really a great way to keep people motivated. I'm amazed that you have continued to make all the menus, achievements etc. selfvoiced. Wow this guy who speaks this must have used a lot of hours on that. This is an amazing job. The voiceovers in generel is awesome. I've found a small bug, which I'm not sure on how to reproduce: I got some achievements while playing the archery game. The achievement message got repeated like three times, after each round. I'm not sure on what I did, but I might have scored the achievement twice which might have tricked that.

Keep up the great job guys. This is awesome...

Musicalman - 2017-07-14
Here are my thoughts and maybe some advice to others:
For the advertisements, I've found the best way to deal with them is to tap the button at the bottom right of the screen, which brings you to the app store. Then I have to turn on Voiceover to close the app store and go back into Audiogame Hub. Not sure if there's an easier way to do this.
As for the Simon and Bomb Disarmer games: Simon is a little different than the tutorial suggests, as you can use different sound packs with the Simon game. You can get more packs by playing the game and you can also buy some from the app store as well. By default, you get two packs: the first is 4 of the 5 blocks from the blocks game (I prefer this one at present), and the second is some drum sounds. I think the tutorial should use one of those packs, since the tones it does use at present are misleading, and it makes the line between the two games even narrower.

Now for Bomb Disarmer. it uses dTMF tones as SLJ described. This is actually kinda funny, because about 10 minutes before I tried that game, a friend and I were talking about how I can improve my recognition of dTMF tones. Well here's an answer I suppose.

I thinki it sort of fits too, since if you are disarming bombs, it makes more sense to be using a dial pad than it would to be using some other device. I know this may be hard for some people though, and I won't pretend to be exempt from that myself; I barely can make it to the third level in campaign mode so I'm still not that good. I do enjoy the cut scenes, and can't wait to complete the campaign mode. BTW you can skip those cut scenes by tapping and holding your finger on the screen for one second.

Unfortunately there's a bug in Bomb Disarmer. In the tutorial, the layout is slightly different than it is in-game. The bottom left and the top right quadrants are reversed.

For the slightly more geeky members of my metaphorical audience, I'll describe the layout of the screen using the DTMF numberings. Thinking of the tones this way helps me remember the sequences, so here goes.
In the tutorial top left is number 8, bottom left is 5, top right is 6, bottom right is 1. IN the actual game, top left is still 8, but bottom left is 6. Top right is 5 and bottom right is 1. Don't sue me if I'm inaccurate, I'm still not good at DTMF recognition! In any case, I hope the discrepancy can be fixed in the next update!

Admittedly, I haven't tried the other games since I assume they are largely unchanged, except of course for the improved menu system which I like. I can't wait to check out Animal Escape and Runner, they sound like arcade titles and I am a huge fan of arcade stuff. I think games like Blocks are also fun, games in which there is a strategic element and there is really no end... you keep going with the game getting harder and harder until you lose. I hope there can be more games of that variety in future. Something tells me at least one of the above two games will be like that, but only time will tell I guess. Regardless I am eager to check them out, especially on the PC since I find the PC version of this app to be more responsive.

Keep up the awesome work!

BigGun - 2017-07-14
I think that up and down menu are good. Pages aren't so important for the blind, it can only help sighted peole like croling etc. And also, Can we perhaps watch an advertisement in slot machines or blackjack and get 100 koins or omething like that?
Best regards, Aleksadnar

Dark - 2017-07-14
Hi.

I've finally got off my rear and tried this one out which actually I should've done a long time ago but ah well.
Firstly, I'm loving the variety of games available, the human voicing and the graphics, great job, indeed I'd be tempted for a Pc version for a chance to play graphically on a decent sized screen.

I do have a few feedback items though:

First, I have no problem paying for games, I very much like the option to unlock everything, however it'd be nice to try the games a little first before deciding. The problem is that whenever I go to the "watch an advertisement" option I'm told "there are no advertisements available" which effectively means I have got to try the games just the once, indeed in the case samurai dojo I slightly messed up the tutorial meaning I don't really get how the game works. I am in the Uk, and as far as I know my phone doesn't have any add blocking software or similar. Perhaps if this is likely to be a problem you could get 10 demo plays, indeed I did wonder the coins you could get in the casino games were actually used to play the main games, but it seems not.
I also noticed a miner bug in the memory game as far as clicking on boxes goes, since sometimes I was tapping on a box and the game didn't seem to register.

On the other hand the games are great in gameplay terms, I particularly liked the sounds for the Sherwood forest animals. The only game I really couldn't get on with was labyrinth because it seemed I couldn't quite locate the exit sound effect correctly, but I will certainly give that another try.

Lastly, you might consider changing the background in the blocks game. I have the high contrast mode turned on, but the background to the game is still white which for contrast purposes is pretty terrible, it'd be much better if it were black like some of the other games.

So, great job, I hope that some of the kickstarter games like the tunnels rpg will also be available to everyone else at some time in the future since it'd be a shame to miss them. I'll update the database with information about the new games.

Musicalman - 2017-07-14
Yeah Dark, I've also had the problem of having ads not available, though admittedly I was spamming the heck out of the ads to get free playthroughs before that, so I thought maybe I just ran out of ads and would have to wait a while before trying again. It's very likely the PC version will be out soon, with the old version of Audio game Hub there was a PC version which I liked a lot better than the IOS version since it was more responsive and had better sound.

If you guys would like, I can try to make an audio tutorial/demonstration for Bomb Disarmer and Simon so you can hear them in action. I'll probably do it later today.

Sonnar, I'll be sending you an e-mail shortly.

Dark - 2017-07-15
I'm afraid I still have seen none of these add videos at all after several tries today I keep being told adds are not available.

while I am not against the adds system, a free to play system which is effectively unusable is not a good thing and might make some players feel they are being cheated extremely, even on a demo basis being asked to play a game once and once only before having to pay is rather stingy to say the least. I would suggest myself that if the current system is to remain, it needs to be made reliably usable like the bit coin adds system used in the blindfold games (which is at least possible to use).

Similarly, the blindfold games start the player with ten tries at each game, not just the one before they must start using the adds.

if the current adds system cannot be made more reliable, then I firstly suggest firstly giving five tries at each game rather than just the one which is a much fairer amount for a player to determine if they want to buy the game, and secondly, consider the daily free gifts extra plays of games if you haven't bought them.

Actually that would be a nice idea, each day, the player gets three random plays on the games, thus giving variety in the gifts, either that or allowing a player to buy extra plays at the games with large of casino game coins, say 100 per play of the game.
complaint over (big_smile).

Dark - 2017-07-15
Hi Jarek, good to know.

Well I have taken the plunge and bought the games since I likely would've done anyway after trying them as I do love the sounds and atmosphere.

Here is a little more feedback:

First menus: It would be nice to skip the intro credits when starting the ap. While I appreciate the work that the various organizations have put into the game (and I love the stereo of the logo), it is a trifle long winded to hear these every time.

Now about the games: First, hunting, the graphics make this one rather easy, it might be interesting to have a night

time hunting version for sighted players where you have nothing but the sounds.

I played the game by sounds and finished it, then looked at the screen to see if there were any graphics and finished without missing a shot.

Second, samurai dojo: This is a really cool game, but sometimes my taps do not register. On one occasion I got 412 taps, on another when I was tapping faster and the screen was a constant red I just got 170 or so. Given it is possible to literally drumb your fingers on an IPhone screen, you might either consider making the game a bit more sensitive or letting the player know that tapping too quickly can confuse the game.

Next when playing Simon I had a rather odd occasion when the background for the simon menu started up mid way through the game. I am not sure if this is intended to try and distract the player (like those occasional clanks in samurai dojo), but it was a little odd, particularly since it did not stop until I actually went back to the games menu.

Bomb disarmer: I really like this game, particularly the atmosphere and quotes. one thing I did wonder though is if you considered a couple of options to make it slightly different from being essentially a random version of Simon. One idea for example might be to have the buttons have different labels depending upon the bomb.

So in some bombs you have a sequence of tones as you have now, in some bombs you are told letters a b c and D, in some bombs numbers 1 2 3 and 4, in some bombs Greek letters alpha beta gamma and delta, perhaps even with eccentric sequences like earth air fire and water, or Monday Tuesday Wednesday and Thursday etc.

Since it would always be a sequence of four and the four would always be in the same places, eg, first on top left, second top right, third bottom left, fourth bottom right the player have to work out what was where according to the new sequence, thus making it an exercise in split second logic as well as memory.

I'm afraid with memory I am still finding the bug related to where to touch the boxes a little problematic, especially on the final 24 box round.

With the Casino games you might also consider offering a few prizes which players could buy with money. These could include Simon Soundpacks, but also other unlockables for different games, for example some different ambience environments for Samurai showdown to put you off your swinga little more or some alternative sound schemes for memory (the animals are definitely fun but you could sort different things in boxes).

You might even consider having specific collectables or little trophies to buy, just for collection freaks.

Definitely a great job with the games, thanks again, I'll be looking forward to seeing new additions.

Amerikranian - 2017-07-16
I have problems with 3 of you're minigames:

blackjack: the game says you cant split, yet, it's a critical part to the game: it cant be played without it, simply cant! 2, when the deeler draws a card, it doesn't add up to his total, let me show you an example:

i have a jack and a 7 in my hand, dealer has 6 showing. I stand. Dealer draws a 4, so now they have 10 points in total, see the problem? it doesn't take in account how much the second card in the dealers hand is worth, thus, affectively, screwing the entire strategy.

2. bomb and simon: sorry, what's the difference, cause i sure as hell don't see one.

an idea for a game.

poker: clasic game of poker, nothing less nothing more, swipe left and right through the cards, swipe up or down on a card to hold/draw, and when you're finished double tap the screen.

Sebby - 2017-07-17
I like the Blackjack dealer. She sounds very amused all the time. smile

I think you should combine "Bomb Disarmer" and Simon into the same game, as different modes of play. They are, after all, the same game! And please allow Bomb Disarmer to use sound packs; the DTMF tones are really hard for me to distinguish, not to mention uncomfortable.

For "Memory" and anywhere else this applies, please try to mimmick VoiceOver. Once a box is selected by dragging, double-tap anywhere means double-tap that box. Ditto the corners; once swiped or tapped, now double-tap anywhere activates them. Otherwise you've got to carefully double-tap in the exact same spot you found them, which I find to be quite hit-and-miss.
Edit: thank you Raygrote, that helped a lot re the DTFM and I can see how that makes sense, also thanks Jack for pointing out the differences between this and Simon. I still struggle, and believe as it's not core to the game, there should be at least alternative types of beeps. Simple tonal sine waves would work OK for me.

Dark - 2017-07-17
I'm afraid I don't agree with simon soundpacks in bomb disarmer. It's supposed to be a different game with a different atmosphere and something of a story behind it, and it would be just plane wrong to have say drumbs or animal sounds or whatever on a dangerous bomb, plus then there would be little difference in the two games.

Myself, I would suggest as I said above making the bombs use something like spoken numbers or letters or something else in words to distinguish them and make the game less like Simon.

Extract of submitted forum posts on AppleVis forum

AppleVis forum posts
JeffB on 23 April 2016 Hi this is a fun game! Can you add a way to go back to different menus? For example if am playing one game there is no way for me to go back and pick a different game without closing out the app. using the scrub gesture would work well here.
music fairy on 24 April 2016 hello. to go back, you have to find the very left hand corner of the screen. it should say return. double tap their. if you double tap anywhere else it won't work. it takes some getting used to but it works eventually. as for the double tapping, where are you when you try and it fails? i am also on an iPhone six with the latest iOS
Ornella on 24 April 2016 I love this app very much. I know I wil have fun. 1 question about the casino table how to get it to say what's on the wheels after I pull the handle?
David Standen on 24 April 2016 I really love this game. I have only tried the blocks, memory game and labyrinth so far but plan to try the others very soon..
HarmonicaPlayer on 24 April 2016 when I went to where you can upload your high scores to the audiogamehub.com site it says page don't exist:(
tunmi13 on 24 April 2016 I've played only the same games that DMNagel has said. I like the Samurai Dojo one, that's cool. Also the labyrinth is a really creepy game, you can hear monsters and stuff, it's crazy. And the hunt one is cool, the raccoon almost escaped from me, but with my handy bow I shot it. So this is a great app, and also, it's free!! No in-app purchases.
Ornella on 24 April 2016 when I reach down to the last 2 boxes to open, it sometimes won't move. I just hear the tapping sound. I hope it could be fixed sometime. I also like archery
Clare Page on 25 April 2016 Hi! After reading about Audio Game Hub here yesterday, I decided to install the app, and I'm glad I did. I've tried out all the games except Labyrinth and the two samurai games, and I like them all, even though I'm definitely better at some than at others: for example, I could say that animals are relatively safe from me in the hunting game, given the amount of times I miss them! As was pointed out above, the positions of buttons and other objects on the screen in these games can be very precise, but playing these games fairly regularly should help me get used to that. I have not tried posting high scores yet, but here's hoping my high scores from yesterday are saved when I reopen the app so I know in future whether I've beaten them or not.
Ornella on 25 April 2016 That would be nice but maybe you could contact the developers and give your suggestions. I was checking for reviews on the app store but there wasn't any.
Joseph on 17 May 2016 So I have a question. instead of having users of this application upload scores directly to your site, why not find a way to have this game intigrate with game center? Other developers have done this and it works well. Plus it simplifies things for the end user. That's just me though.

Kelly Sapergia on 8 December 2016
I just installed this app on my iPhone 5C, but apart from the opening announcement about using headphones, I get no additional speech afterwords.

All I hear is a beep on the left side. Touching the right part of the screen gives me a beep on that side.

Does the app even work on a 5C? I know I tried it with my iPod Touch a few months ago and it worked perfectly then. If yes, is there something else I need to do to proceed?

Chris on 9 December 2016
Try uninstalling and reinstalling the app. If that doesn't help, it's probably your device. I can't think of a reason it shouldn't work. It works just fine on my iPhone 5S. Unless the game requires intensive processing power, you should be fine. You may want to reboot between uninstalling and reinstalling. Better yet, try rebooting once after uninstalling and once again after installing.

Paige on 16 February 2017
This game is so awesome! I got it an hour aagain and i am already addicted. I'm not very good yet, but i'm practicing! I just have one question: how does the multiplayer function work? If i press versus it doesn't give me an option to pick who to play the game with.

---

harry6116 on 23 February 2017
i would love to see a tennis game or realistic combat simulation.
even a flight or train simulator.

---

kool_turk on 23 February 2017
This game would really be a lot better if we could play people online, not just pass the device to the next person.
If you're going to do that, then there's no point logging into a google account or game centre, unless you actually care about the achievments.
Achievements are ok, but not if it's only for bragging rights, then it's just boring, just my 2 cents.

Ashleigh Piccinino on 20 December 2018

Hello,
This app is really fun! However, I wish we could take items into the labyrinth so that we can better survive. For instance, there was either a dragon or something else and Labrinth one today. I somehow wish we could take a sword or something in there to kill the dragon or whatever it was. Also, what about having a flyswatter to to swat flies when you hear them? I think it would be pretty awesome to do those things, however, I am finding that this particular game could be useful for Owen M training purposes. It’s a good game, so keep up the excellent work on it. Thank you,
Ashleigh Piccinino

User reviews on App Store and Play Store

This section outlines the ratings and user reviews across both Android and iOS platforms between the launch of first version of the *Audio Game Hub* (15 April 2016) and the end of data collection (18 June 2018). In this time frame, the *Audio Game Hub* collected 1,115 ratings with 566 reviews. There is a significant difference in the number of reviews between the two platforms (iOS only received 58 reviews). Overall, the *Audio Game Hub* retains a very high average rating of 4.71 out of 5 on Android and 4.0 out of 5 on iOS (see Figure D.1 to D.4).

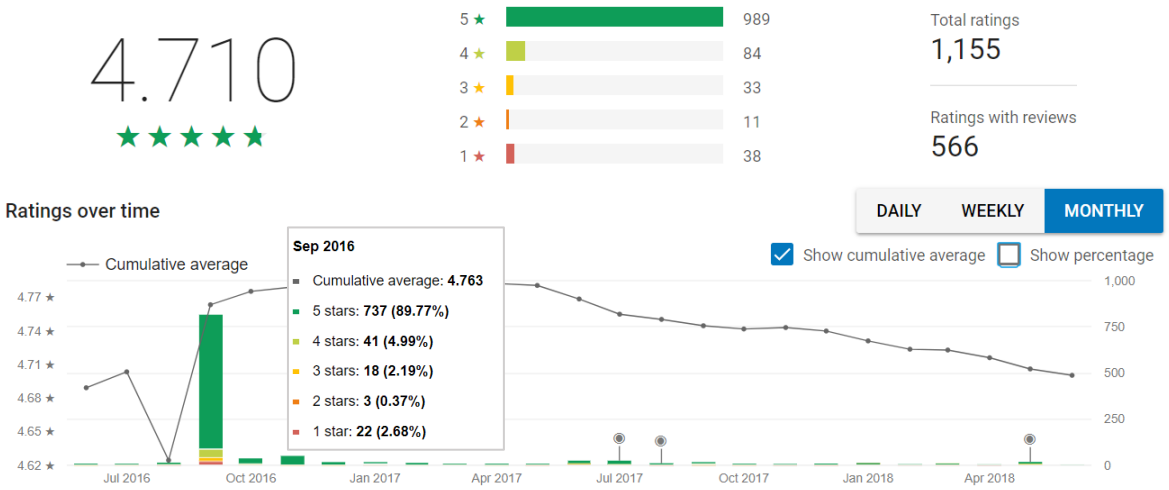


Figure D.4. User ratings overview of *Audio Game Hub* on Android (15 April 2016 – 18 June 2018) (screenshot from Google Play).

Figure D.5. User ratings overview of *Audio Game Hub* on iOS (15 April 2016 – 18 June 2018) (screenshot from App Store Connect).

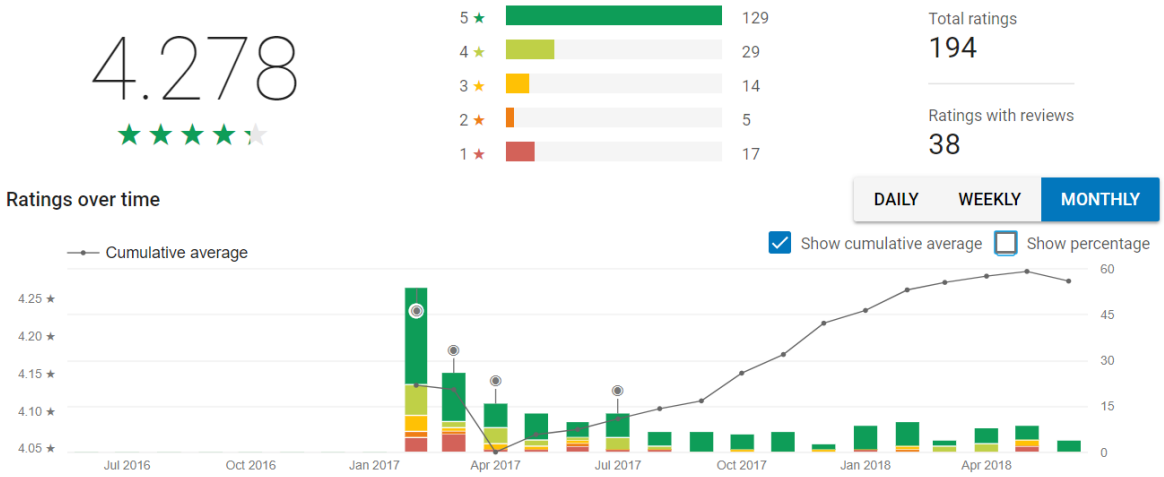


Figure D.6. User ratings overview of *Blind Cricket* on Android (01 February 2017 – 18 June 2018) (screenshot from Google Play).

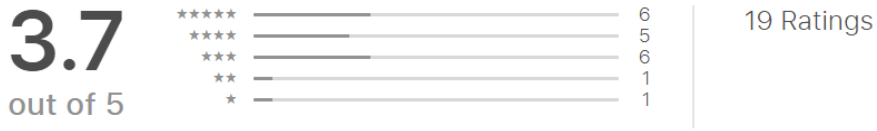


Figure D.7. User ratings overview of *Blind Cricket* on iOS. (01 February 2017 – 18 June 2018) (screenshot from App Store Connect).

Similar to the *Audio Game Hub*, *Blind Cricket* received more reviews and ratings on the Android platform. The method of asking ratings was identical for both games on both platforms. The higher amount of Android ratings might be due to the overall higher number of users on this platform. Overall, *Blind Cricket* retains a high average rating of 4.278 out of 5 on Android and 3.7 out of 5 on iOS.

Below is an extract of written reviews (the total number of reviews exceeded 600) from all games and platforms. The reviews were copied in their original form (including grammatical or spelling errors) and are publicly available online.

Extract of written user reviews for *Audio Game Hub* and *Blind Cricket*

Name	Rating	Review
Alf Richard	★★★★★	Alf Rikard from Norway 41 years: Very BEST game for blind users and others – got addicted!!! I am almost blind and Spinal Cord-injured , sitting much alone in my manual wheelchair using my iPhone and iPad 12,9". There is few games for blind or VoiceOver-users, but this one is the VERY BEST I EVER experienced, especially when I put on my headphones, the voices in this game sounds real, you can hear them breath, and sounds are very realistic, sounds goes from left to right, up and down and all directions, VERY VERY GOOD!!! Give it 5 ***** today (Tuesday 16. Jan. 2018)!!! Could been more advanced and more games and levels and maybefruit/slot-machine-simulators with 4-reels, hold and so on (more Casino Games? Got "addicted" immediately after first day! Going to tell other about this game!!! Waiting for new version, so I buy coins and sound packs: – LONGING for next version!
LorDDmitrius	★★★★★	Finally!!! Glad to see people who care about blind people, and made a set of games for them!!!
ty ty	★★★★	I freaking love you guys! The sound quality is amazing! Here are a few more game suggestions for you guys. 1: a track and field style game. I know you guys are coming out with a runner game, but how about a game featuring all styles of events. The meter dash, hurtles, long jump, high jump, swimming, all the events found in a track meet or olympic games 2: pinball. Would love to see what you guys can come up with a pinball game, with a collection of tables based on the 80s and 90s style of games. If possible, I could help with sounds and music. 3: an arcade style shooter. Now here's where you guys can really get some work here. A 90s style arcade shooter, well, late 80s, early to late 90s shooter, with stages, challenging bosses, tons of powerups, and some killer music to go along with it. 4: puzzle league/tetris style games. I know you have blocks, but a puzzle league style game, where you make chains and blocks disappear would be fun. 5: racing: now that would be fun, an audio style of racing game. Finally: more styles of slots in the casino. Now if you haven't been to the US, or if you guys have a team that works in the US, and have been to Vegas, the newer slots they have now sound amazing! Of course, I would like to assist, especially with music and sound. These slots can easily be fun, with 5 reels, mini bonus features, and bonus games to maximize winning. Plus, not to forget, the newer ones have the bonuses where depending on how many symbols you have, you can get free spins. Oh, let's not forget the jackpot prizes. Mini, major, minor, and grand. My favorite reason I love the newer machines, is that they have more variations of the payout bells, wither it be chimes, and they sometimes have different tunes for denominations of payouts. If you want, please reply and we can get in some contacts, and I can send you some ideas of how the games work.
Christian cool dude gaming	★★★★★	Hello, thanks for making audio game hub. There is one game that I want you guys to make. I want to experience roblox but in audio form. My brother has played it, and I want to start playing it too. I mean just imagine, how cool it would be to have roblox in audio form. If you guys can make this it would make me so happy.
Nathaniel Door	★★★	I really want to like this game and support it. But I found the first game I played - Samurai Tournament – to be very buggy. The voice says "Round 1" for round 1, "Round 1" again for round 2, and "Round 2" for round 3. Sometimes the opponent and I both get points. I'm not sure if this is due to a tie, as the instructions don't mention that possibility. I ended the last game with the opponent having 3 points, while I had 1 (according to the number on the screen). Both of us got that last

		point at the same time. The voice announced I had zero points. When announcing the time, the voice says "0 point 57 seconds" when it means "0 minutes and 57 seconds" (or just "57 seconds"). Also, at the end of the game, the time it gave me was some ludicrously high number.
robjken	★★	Very well written, but I have visited many casinos around the world, but I have never played under rules like these blackjack rules. Do you Guys know how to play or have you just read a book?
Djfelix2020	★★★★★	Already addicted! I have been playing for under a week and can't stop playing.
Noandy	★★★	This was great until the last update that pushed through on July 23. Now when the app is loaded, nothing happens. Once that is fixed, it will be great again. :) Update: still having same problem for 7/25 update but maybe it's just me. I don't see anything on Applevis about this.
Omid qand	★★★★	Annoying Narrator. I really appreciate your all efforts to develop this game. However, the latest update, The narrator became a very talkative! He announces all details which is not necessary. I guess It is annoying; I lost my interest to play.
Addicted to Solara	★★★★★	These games are great. They're simple, but challenging at the same time. I really enjoy the variety. I don't know if I'll ever get out of the labyrinth game, however. Thanks for developing such creative games for us to play. It's nice to have something that works for a voiceover user. It's cool that anyone can use them, however.
TallyChip	★★	Disappointing. Not challenging, not interesting. Frustrating design requires you to turn off VoiceOver.
Rich Beardsley	★★★★★	Great game, but developers cannot be trusted. This app is great. Many games on here are a great past time. However, the developers of this game promised us an update back in April, and now it's already June and we still have not seen an update
Wenderson Cruz	★★★★	It would be nice if the next update translate the game also to Portuguese
Efraín Hernández	★★★★	Please translate to Spanish
Melinda Sanchez	★★	I thought this is a free game and off line game.I thought this is a free
Doğancan Kalıncı	★★★★★	The game is very nice But I have a problem like this when I play a game Sometimes when I play the game End the game Then after I go through the menu in the game menu When I wander through the options I do not say anything when I scroll through the options Just read the sound effects When you enter again you will only get double tapping sound effect and when I enter some games For example in hunting game this is the problem from archery game when I start the game I can not detect my double click I am experiencing a problem like musical Please fix this problem I need to remove and reload the game To update this problem, I have been having this problem often since 2.0
Blind-Droid Tech	★★★★★	This audio Game Hub is amazing. Great to see developers are attempting to reach the Blind and Visually Impaired community please keep up with the updates and keep the game going for years to come. I have already donated for a few of the games that I really enjoyed. I would love to see chess, Checkers, solitaire some sort of dice game, and maybe another casino game or two just to name a few. Nice thinking outside of the box, and keep it up. As long as you stay loyal to the app, I will stay a loyal user. I have already put up a demonstration of the app on my YouTube channel for others to see.

André Baldo	★★★★★	**The games are simple, but the sound quality, and even the possibility to compete against sighted players, make Audio Game Hub something to recommend and even share! Keep up the good work not only in developing but also in fixing eventual bugs!**
Judi the Mexican beauty	★	My niece wanted to download this game and her iPad is iOS 9 and the game does not work goes totally black the screen and we are trying to uninstall it and install it again to see if it'll work but it still doesn't work if you guys fix this I promise I will give you guys much much better review!
Themusicman08	★★★★★	This is a great app for those who love games I heard about this app from a friend of mine who was searching around for games. I've heard about the computer version first. Then I heard they were going to make a version for the eye devices. Once that came out, I immediately was hooked. If you guys haven't tried this, you certainly should. It's well worth it.
bill cool	★★★★★	Fun app for kids with low vision! My daughter is writing this review she is 8. Some of the games are harder than others. I don't like how there is no option to turn off timer or get extra tries on super Simon. Instructions are easy to follow and i can see most of the pictures, which is cool. Thanks for making this app!
Tuan Bui	★★★★	Too many micro transactions and adds or lack of availability hamper what might otherwise be an enjoyable experience. Please give us more game freedom without constantly tugging at our wallets so much
Navnath Randive	★★★★★	Hollywood game hub is the best app for visually impaired community I have ever come across and this has given a wonderful experience for those who cannot see but still they can enjoy the fun of playing games on the cell phone I would like to wish the entire audio game hub team for building such a wonderful app for visually impaired community and wishing them all the best for future last but they are not the least I would like to say sorry for spelling the first word instead of audio my Google voice typing has typed Hollywood instead of audio to the beginning of this review so for this I feel very sorry and irrigated for making such mistake I hope project team would understand that being visually impaired such mistakes can happen but the above the first word Hollywood I didn't mean that it was supposed to type audio with the Google voice typing has typed Hollywood instead of audio so kindly ignore that mistake thank you
Emery G. Taylor	★★★★	I love the idea of this game hub and I love even more that somebody in the gaming industry finally realized because people are blind or vision impaired doesn't mean they don't want to be afforded the same entertainment options as their sighted counterparts. The games are pretty simple to use and obviously a lot of thought went into making this as realisstic as possible. As a blind user I thank you for thinking outside the box and developing such an app. I would like to eventually find Yahtzee and Solitaire on here too but so far very impressed.
Geovana MNS	★★★★★	Super! I came here by Wuant and really the game is very good! I have only one complaint: The audio of the game would pause when you receive a notification
Leonardo Solis	★★★★★	DA Best Even though I am not blind or visually impaired you should try it
Tom Randall	★★★★★	Really good games. I'm really glad to see some audio games for the Android platform, after running this for the first time I discovered my acapella voices had been deleted o Talkback would not function. However I'm almost positive this was just a freak thing because I've run it several times since reinstalling the voices with no problems this is why I'm updating this review and giving this five stars. This is great we need more audio games on Android.
Gabriel Santos	★★★★★	Unbelievable All the sounds are perfect good and makes you feel in another place

Jacky Kumar	★★	These games are very expensive. So make it free
RYAN HSU	★★★★	I know watching ads to play games is a good idea, but come on! Do you really think a blind person can watch ads and find where the close ad button is?! That's the most awful thing in this game. Other else is great... maybe you can pay coins which you earned from casinos?
Christian Vanneste	★★★★	Pretty cool game, tryed on a OnePlus 3t. But consume to much battery, heated the phone enormously. Realy, even in blind mode. I found a lot of bugs too: double swing so double runs, weird reactions on versus when i click continu in the main menu, I probably had to forget one or two. I think the most important problem is The speed at which the battery discharges, This is why my four stars. I hope this help, Looking forward to an update!
bigboy529	★★★★★	This is a great game but it can do with a few more difficulty levels in order to make it more difficult to finish the career mode. Apart from a couple of achievements, I managed to finish the entire game in less than half a day.
HarmonicaPlayer	★★★★★	blind cricket is totally cool:) The swiping method of play is very easy to grasp:) The game is self voicing and its easy to follow:) It is verry eddictive and i am sure you'll love it to:) I give game 5 stars:) keep up the good work sonar folks:)
Max 71530006	★★★★★	How about 500 stars. I've been looking for visually impaired games for months. Thank you for making such a useful and accessible game. I completed my first game just today
Fp121	★	I downloaded this game two days ago I am facing issues with career mode whenever I launch the career mode after selecting new game it is not taking me to the first level of play but taking me to the practice mode of the game I am not sure where I'm going wrong I need some help and guidance how can I correct this for your information I'm using iPhone 7 Plus with iOS 10.2.1
Braille kid	★★	While this game is extremely fabulous, I am very sad. I understand that the support is needed for the company, but I think that it should not be something that is mandatory. Some people can barely afford to pay their own way in life, but it should not be so difficult to find a game that is actually free to play on our devices. If there was an option to check that said that donations could not be made at this time, and we could still play the game, that would be great! I would really love to play the two levels that require me to support the company.
Kiwi Carol	★★★	I love the audio games hub app so was excited to see this one. Sadly it is not as good. The app is confusing when you first open it with the google login. It is not made clear you can pass this. Then navigating around the options is slow and not as reactive. This needs major improvement
She'ssbbsnsnsnsnz	★★★★★	Love this app. I am into audio games and love it. Do you think you guys can update it with more games? Gave it five stars. I would recommend it to every other visually impaired person

User emails

This section features extracts from over 100 emails that we received during the project. Most of them were about feedback and user experiences with our games, but they also included proposals from industry specialists, journalists, bloggers and PhD students wanting to collaborate with us. The emails have been copied in their original form (including grammatical or spelling errors). To preserve user anonymity, the last name has been redacted from each entry.

Extract of emails received during the *Audio Game Hub* project

User emails
Hi, I wanted to write this email to express not only my thanks and gratitude but also my complete amazement of your Audio games hub app. I am partially sighted and my wife is fully sighted and to be able to play games with her is just fantastic. You made possible something I thought I wouldn't ever see. It's about the games yes certainly, but the experiences, the laughs and fun we can have because both sighted and visually impaired people can play these set of excellent games together. So for the fun we have had so far and the fun we will have in the future I can't thank you enough. I hope more games will be on the way, at the moment Android doesn't have allot of high quality audio games but yours is certainly one of the best. Thank you and take care. **Riz (27.04.2016)**
Hello, I'm writing to tell you how much I love this app! I'm blind and use it on the iPhone platform, and it is so great to finally have an accessible game hub app. I have a couple of suggestions to enhance the games. Have you guys thought about making a casino, where you could have slot machines, blackjack, and other casino games that way we could have more to choose from? Also, maybe you guys could create a pro version where one would have to pay a little bit and you guys can include some extra games as well, because I would love to be able to support you guys even on a fixed income because this is such a wonderful app! Please let me know if you have any other questions or would like me to provide you with any more feedback. **Mary (08.05.2016)**
Hello guys, I would be very interested in supporting your campaign on kickstarter, since I am very interested in the exclusive game as well. Unfortunately, I have no sighted help to find the numbers on the credit card and I don't use it so often. Would it be possible in this case, to support you via paypal instead? And could I get the exclusive game if I would donate this way as well? Would be fantastic if we could find a way for this. And another question: Is internet access required for the exclusive game or is it completely playable ofline? Thank you in advance. **Niklas (14.11.2016)**
Hi Jarek Beksa, I came across your company @ AKL gamedev meet-up digest and followed on Kickstarter. I am looking to relocate to New Zealand and looking for opportunities. I would like to make an open application for an additional audio position with Audio Game Hub. Hence sharing my details and looking for a chance to interact with you.

My Portfolio includes game audio design from concept to completion and defining audio pipeline. Work includes concept audio design document, audio asset documents, designing sfx, sound integration in Unity, audio optimization, audio mixing, music implementation, working closely with multiple teams within the company such as programmers, artist and QA. Also, managing third party vendors for Music and VO production.

Parag (23.11.2016)

It was such a pleasure trying out Audio Game Hub, providing you feedback, and talking about the app on "Speaking Out for the Blind" that I think it might be good to interview you about AGH for the show. It would be a thirty-minute interview, conducted via Skype, and be prerecorded to air on ACB Radio later. My skype address is bradioman1 and I was wondering if you'd like to be interviewed on December 5th through the 9th or December 12th through the 13th anytime after 10AM Pacific Time. I'd like to do the interview on December 5th. I'll send you a script if you're interested.
Thank you. Your assistance is very much appreciated.

Brian (03.12.2016)

I have a student who is blind who LOVES your app. However, when we opened it recently it is no longer giving feedback regarding what you are selecting or how to play the game (the voice). I tried turning up all the sounds in settings. The sound FX are working, but not the voice. I also cannot click on the information button. Help! This student loves your game, and I want him to be able play. Thanks.

Jenny (20.12.2016)

Hi guys.

I wanted to say I really love the AG Hub. I run a YouTube channel where I primarily focus on audio games though I've done console games in the past. I made sure to donate to kickstarter, but I wanted to get permission to be able to do play throughs of the new games when an alpha is released. I wanted to get your blessing before I embarked on this project.

Liam (22.12.2016)

Hi.

I'm the Editor of a UK-based e-newsletter and blog (sent out and viewed across the globe) on technology access for persons with disabilities, e-AccessBulletin: http://www.headstar.com/eablive/ .

I've just read about Audio Game Hub and your Kickstarter. It sounds like a fantastic project and hugely relevant to our audience. I'm writing a news piece on it for the December issue, sent out in a few days. Would you be able to help with a few quotes for the article? I've put together a couple of questions below - would you be happy to answer them, so I can accredit a quote to someone from AGH? If so, is there any way you could send me back answers by first thing Wednesday morning? Sorry for the tight timing! Christmas publication deadlines have made things very hectic here.

Kind regards,

Tristan (20.12.2016)

Dear The Audio Game Hub Team,

My name is Hayden and I am a final year student at The University of York (UK), studying Electronic Engineering with Music Technology Systems.

For my final year project/dissertation, I am looking to develop an interactive 3D audio only game for iOS. As part of my initial research for the project, I came across your company and the brilliant audio only gaming series you have developed. I think the ideas behind them are fantastic and I am really interested to find out more about the game mechanics and audio implementation techniques that were used. I was wondering whether there was anyone I would be able to contact to discuss this all further?
I really appreciate your time and would be hugely grateful for any advice and/or comments you may be able to offer.

Yours sincerely,

Hayden (24.02.2017)

Hi Audio Game Hub,

I just wanted to send a quick email to say that I love what you guys are doing with audio only content. I'm a composer for film and television and I've been involved in several audio visual games over the years. I love the power that music holds in telling stories so I welcome any advancements in media, technology and interactivity that will help to elevate sound and music as a tool for engaging the imagination of humans of all ages, especially those with vision impairment challenges. Your work is helping to bring richer content to those who cannot appreciate the standard visual-biased content that flows through our devices.

Please sign me up to your email list and if there is ever anything that I can help you with then please make contact. Look forward to crossing paths with you soon. Many thanks,

Julian (08.08.2017)

Hello, We are a French company taking in charge peoples that are beginning to loose their hearing. Among numerous other topics, we would like to raise the awareness of our customer to what is important when hearing (recognize non-verbal sounds, localize sound sources, etc.).
One of the way is to create some games like the ones you have developed in Audiogamehub. We have already found some abandonware in French that we would like to adapt on our mobile platform.
Would you be interested in collaborating with us? We could be your entry door to some very different population than your usual customers, geographically and sensorially. Thanks in advance. **P. (14.05.2018)**

---

hello. my name is vlad from audio games.net forum.
i am contacting you because i'm interested on helping you with testing your products. i really like your games, and i want to support the creating of new ones.
best regards,

vlad (15.06.2018)

Hi. wow, never dreamed that audiogames industry would move outside the us.
I am shaun, I have played audiogames for about 10 years or so. Currently I do test and sound design for a company called reality gaming using realistic 3d sfx with a l=engine called free sound library with pure basic. I have also done research for Auckland university p psychology department and business department on several projects. I have forward your message to the gaming hub and will forward this to other places to in the next little while. I have not played 1812.
I suggest you put yourself on http://forum.audiogames.net which is the main hub, I think heart of winter was discussed on there. I had no idea a local made this.
its good to have someone from my country especially Auckland the city I have been born in and am in fact still living in. I have a laptop, external keyboard and mouse, tell me what you need to test and I'll do it.

Shaun (06.05.2016)

What a great initiative - well done. You've described the concept well and the potential application is obvious - the size of the opportunity here is phenomenal. In terms of your entry, you could provide more information on where you see the health/wellbeing benefits accruing - this could be physical, or mental/emotional. Sonnar Interactive is something I was not aware even existed, and highlighting the interface between non-sighted and sighted is an exciting feature of this project. Further information on where you hope to take this project on a larger scale would also be helpful (development of paid apps, introduction into gaming competitions etc?) It's surprising in a world where gaming has become ubiquitous, that such a market and niche has been left out! Bridging the gap where all users - sighted and non-sights - can play is key for growth! We must never forget the important of having fun, and you've sought to bring fun to everyone. We look forward to seeing more from you as you commercialize and generate income.

Fiona (17.11.2017)

Hi Jarek,

it's Eric from the Blind iPhone on Twitter. So, I have 2 kids, one is 17 and one is 5. They are both sighted. I have RP so I am legally blind. They both love games and are very competitive. I was playing a few games on the iPad and my son, the 5 year old, came over to look. Surprisingly for an audio game, there were graphics so he could tell what was going on. I went through most of the games and found the Samurai games. I played Samurai Tournament and did well so when my daughter passed by, I challenged her. She crushed me…lol. We were laughing and my son came by. I put on the Samurai Dojo game and we put it to 4 players

and took out the 4th player every time each match started. We were on the game for at least 1 hour taking turns at winning. Eventually, I was losing more than winning because my fingers are bigger and in 4 player mode, the corner tap section is small. All in all, we had a blast playing Samurai Dojo. We went through a few other games as well. My daughter loved and completed the Archery game. on her second time playing. I am pretty good at games, I still hold the top 2 spots on Audio Defense. I usually beat most games but having graphics on an audio game letting Sighted people play with blind people is a great idea.

Eric (03.04.2018)

Dear Audio Game Hub Team,

My name is Michael and I'm a Ph.D. student from Vienna in interaction design (Vienna University of Technology). I'm a passionate audio game player, and I like to learn more about how audio games are designed, developed, created, made, or tinkered, etc. What I'm most interested in are the experiences audio game designers make when putting a game together. My motivation and goal is to create tools for audio game development to support the process and furthermore to understand the process itself.

I recognized some of your work (or your team work) and I wondered if you would have a quick chat with me (e.g., using Skype?). This favor would be highly appreciated, because I depend on input for my efforts to create better tools for audio game design. This input can be anything that seems relevant to you, maybe a common problem when developing games or a tool that you would like to have, or even information about things that are not needed, because they already work fine. I am very grateful for any comments. I am interested in your opinion, no matter whether you consider yourself a game design genius or a bloody beginner J Of course, this is not about business or game ideas etc.; I am interested in the meta-level of designing games, in the experience of people who share the same interest for this relatively rare genre. I have no commercial interest, this work is for academia, to make audio games more popular and to increase awareness. In case of interest, I attach a link to one of my first (theoretic) ideas below [1].

I'm looking forward to your response and do not hesitate to ask if you have any further questions. I am also happy to share any information about audio game design that I have researched so far.

Kind regards from Austria,

Michael (08.03.2018)

Hey AGH Team,

My name is Maxim and I lead the Accessibility vertical for Google Play. We've come across your project and would like to get to know you better.

This morning we announced the 2018 Google Play Awards. The program includes 9 award categories ranging from Best Breakthrough Hit to Standout Startup. If you haven't seen already, congrats! Audio Game Hub has been nominated for the Best Accessibility Experience award category.

Congrats again and attached is a banner to spread the great news across your channels and a PR guidelines doc if you're interested in publishing a press release. Make sure to stay tuned as we'll announce the winners Monday, May 7th at 7:30pm on our blog. Thanks,

Maxim (25.04.2018)

Greetings Jarek,

I wanted to introduce myself, I am Founder and Executive Director of The AbleGamers Charity. The $4,000 pledge is from the AbleGamers Charity. We are excited to see this, and happy to see this be a thing.

Be well,

Mark (14.11.2016)

Appendix E – Audio Game Hub and Blind Cricket results

This section presents the *Audio Game Hub* and *Blind Cricket* results including:

- application analytics
- web analytics
- revenues
- awards and recognitions
- conferences
- media coverage

Application analytics

Google Analytics,[245] Facebook Analytics[246] and Firebase Analytics[247] were used to record user activity inside the applications. These tools were also utilised to collect information such as gender, age, country of residence, device(s) used and user behaviour relating to how users spend time with the application.

With the release of *Audio Game Hub 2.2* (on 17 May 2018), we replaced Google Analytics with Firebase Analytics due to its superior compatibility with the Unity 3D engine. The *Audio Game Hub 1.0* PC Windows version was not upgraded (it contains only eight initial games) and remained available for downloading through our website.

Users and usage overview

This section contains the usage overview of the *Audio Game Hub* and *Blind Cricket* on Android and iOS platforms (see Figures E.1 to E.5). A session is the period of time a user actively engages with the application or website. Screen view means a user has activated a certain section of the application, such as the main menu or settings screen. Each view of a single screen is counted individually and includes repeated views of the same screen.

[245] https://analytics.google.com/analytics/academy/.
[246] https://analytics.facebook.com/.
[247] https://firebase.google.com/docs/analytics.

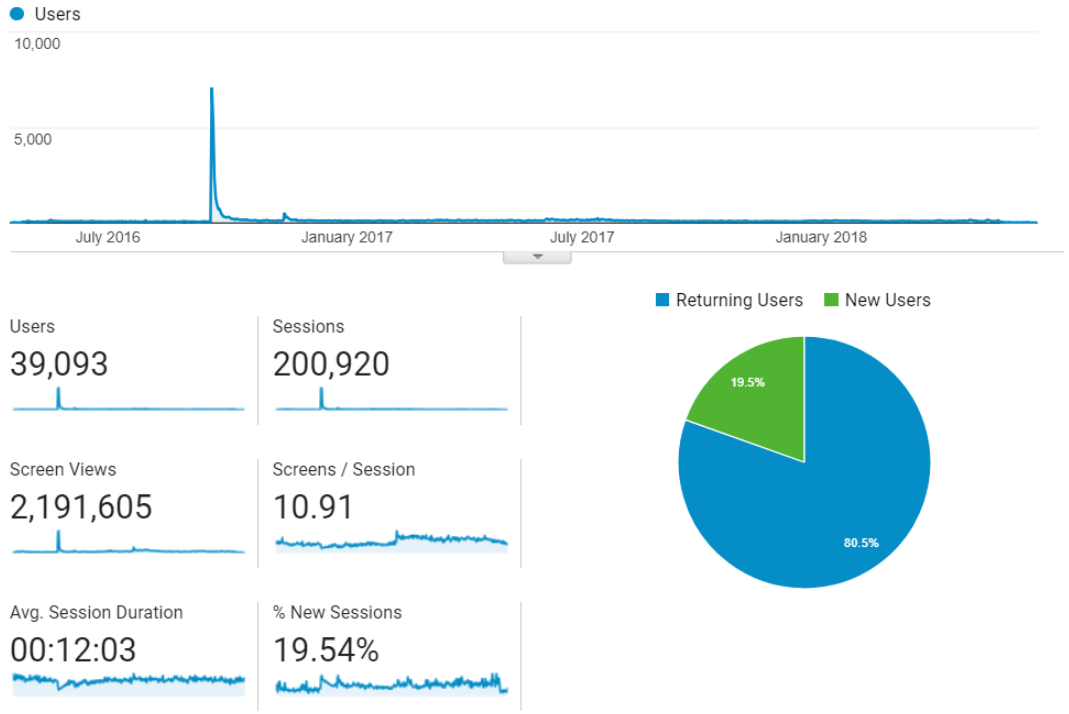


Figure E.8. User overview screen for *Audio Game Hub* on Android (15 April 2016 – 16 June 2018) (Google Analytics).

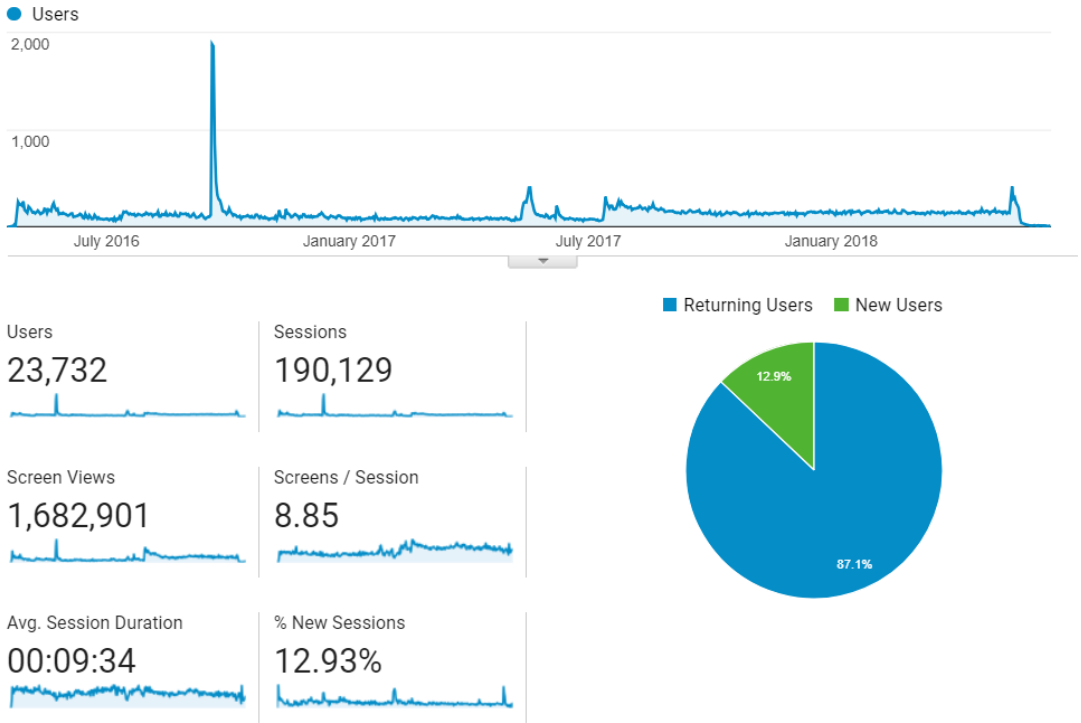


Figure E.9. Users overview screen for *Audio Game Hub* on iOS (15 April 2016 – 16 June 2018) (Google Analytics).

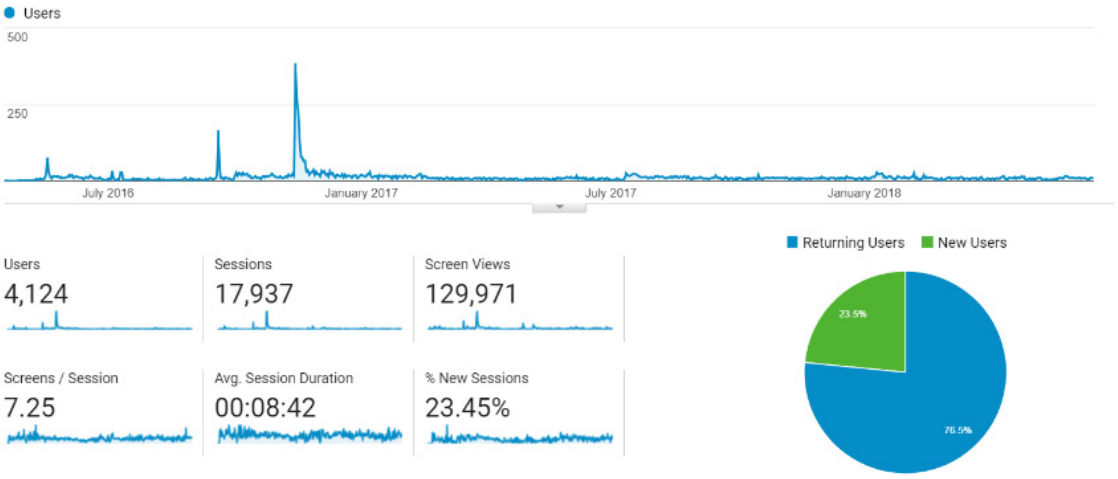


Figure E.10. User overview screen for *Audio Game Hub* on PC Windows (15 April 2016 – 16 June 2018) (Google Analytics).

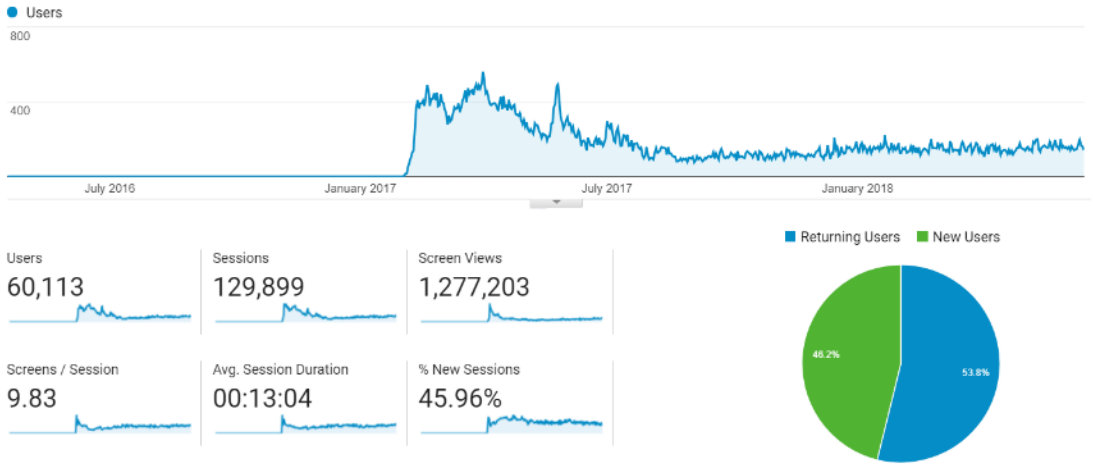


Figure E.11. User overview screen for *Blind Cricket* on Android (15 April 2016 – 16 June 2018) (Google Analytics).

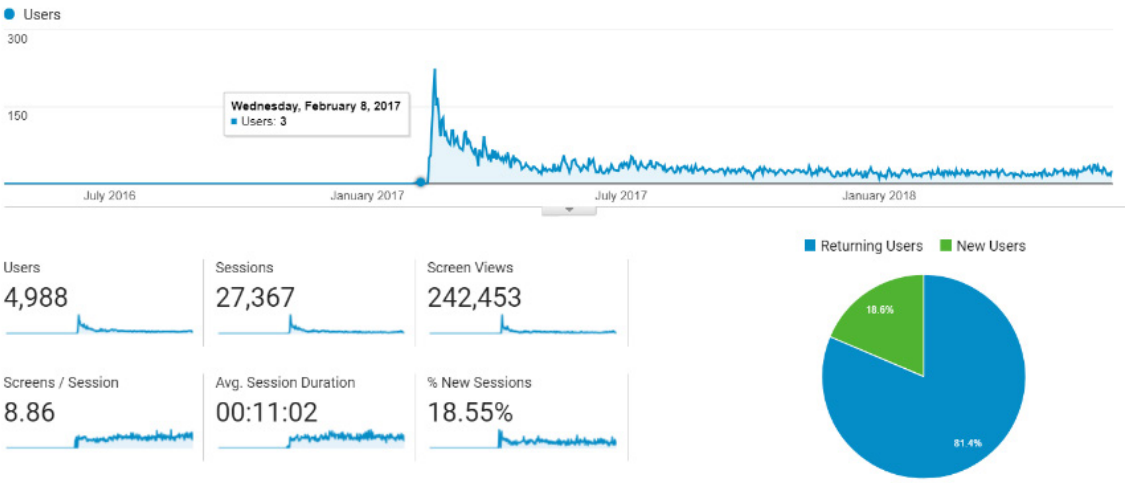


Figure E.12. User overview screen for *Blind Cricket* on iOS (15 April 2016 – 16 June 2018) (Google Analytics).

On 18 September 2016, we experienced a substantial spike in downloads and user activity thanks to a video review by a famous Brazilian YouTuber, Coisa de Nerd.[248] With over 1.5 million views, it generated almost 10,000 downloads in one day (on all platforms). Subsequent smaller spikes were generally the result of media coverage through articles, podcasts or other video and audio reviews, and being featured on Apple App Store and Google Play Store.

An interesting fact about the *Audio Game Hub* audience is that around three-quarters of all users were returning users—this could mean that the games had a high replayability factor. The exception was *Blind Cricket* on the Android platform, where the returning user ratio was 46%. This might be due to fact that most downloads for this game on Android come from India where, according to user reviews and comments on the Google Play Store, 4.99 USD for full access to the game is considered expensive. Without payment, the first few plays are free, after which the user is prompted to buy the full version or watch an advertisement.

Even though the number of users of the *Audio Game Hub* on iOS was almost two times smaller than on Android, the two platforms noted almost the same number of sessions (see Table E.1). This could mean that iOS players used the application more often and were more interested in playing the games. This is backed up by data showing a lower percentage of new iOS users.

Table E.3
User and usage overview summary of the Audio Game Hub and Blind Cricket games (15 April 2016 – 16 June 2018). Source: Google Analytics.

	Platform	Users	New users	Sessions	Screen views	Screens per session	Average session duration
Audio Game Hub	Android	39,093	19.50%	200,920	2,191,605	10.91	00:12:03
	iOS	23,732	12.90%	190,129	1,682,901	8.85	00:09:34
	Windows	4,124	23.50%	17,937	129,971	7.25	00:08:42
Blind Cricket	Android	60,113	46.20%	129,899	1,277,203	9.83	00:13:04
	iOS	4,988	18.60%	27,367	242,453	8.86	00:11:02
Total/Average		132,050	24.14%	566,252	5,524,133	9.14	00:10:53

[248] https://www.youtube.com/watch?v=KuyPECYNKT4.

User demographics

In this section, statistical data relating to the *Audio Game Hub* and *Blind Cricket* users is presented. Due to an implementation error, we could not collect any age and gender data using Google Analytics in the *Audio Game Hub* versions 1.0 to 2.1. Before upgrading to Firebase Analytics, we collected the gender and age data using Facebook Analytics.

Locations and device primary languages

Users in 142 countries have played *Audio Game Hub*, with their devices set to 129 different languages (see Figures E.6 to E.10). Thanks to the aforementioned Brazilian You Tuber, most Android downloads of *Audio Game Hub* came from Brazil (50.02%) and the most popular language was Portuguese (49.02%). On iOS platform, the most popular language was English (33.89%), and the largest number of downloads came from the US.

	Country	Users	% Users
1.	Brazil	19,693	50.02%
2.	India	3,374	8.57%
3.	United States	2,152	5.47%
4.	Philippines	1,485	3.77%
5.	Portugal	959	2.44%
6.	Myanmar (Burma)	940	2.39%
7.	Indonesia	857	2.18%
8.	Pakistan	806	2.05%
9.	United Kingdom	734	1.86%
10.	Nepal	644	1.64%

	Language	Users	% Users
1.	pt-br	19,311	49.02%
2.	en-us	8,595	21.82%
3.	en-gb	2,468	6.26%
4.	pt-pt	1,082	2.75%
5.	in-id	768	1.95%
6.	es-us	664	1.69%
7.	es-es	580	1.47%
8.	ru-ru	573	1.45%
9.	en-in	517	1.31%
10.	th-th	502	1.27%

Figure E.13. Audio Game Hub top 10 user country locations and device primary language on Android (15 April 2016 – 16 June 2018) (Google Analytics).

	Country	Users	% Users
1.	United States	8,358	34.56%
2.	Brazil	4,929	20.38%
3.	United Kingdom	1,430	5.91%
4.	Australia	733	3.03%
5.	Canada	702	2.90%
6.	Germany	536	2.22%
7.	France	442	1.83%
8.	South Korea	369	1.53%
9.	New Zealand	323	1.34%
10.	Russia	306	1.27%

	Language	Users	% Users
1.	en-us	8,128	33.89%
2.	pt-br	4,436	18.49%
3.	en-gb	1,369	5.71%
4.	en-au	740	3.09%
5.	en	624	2.60%
6.	en-ca	548	2.28%
7.	de-de	445	1.86%
8.	fr-fr	427	1.78%
9.	ko-kr	334	1.39%
10.	(not set)	328	1.37%

Figure E.14. Audio Game Hub top 10 user country locations and device primary language on iOS (15 April 2016 – 16 June 2018) (Google Analytics).

	Country	Users	% Users
1.	Brazil	1,539	36.92%
2.	Portugal	751	18.01%
3.	United States	257	6.16%
4.	Poland	194	4.65%
5.	United Kingdom	124	2.97%
6.	South Korea	123	2.95%
7.	Turkey	118	2.83%
8.	India	96	2.30%
9.	Thailand	53	1.27%
10.	Germany	51	1.22%

	Language	Users	% Users
1.	pt	2,251	54.37%
2.	en	820	19.81%
3.	pl	194	4.69%
4.	ko	124	3.00%
5.	tr	122	2.95%
6.	es	73	1.76%
7.	(not set)	70	1.69%
8.	de	68	1.64%
9.	zh-CHT	58	1.40%
10.	th	47	1.14%

Figure E.15. Audio Game Hub top 10 user country locations and device primary language on Windows (15 April 2016 – 16 June 2018) (Google Analytics).

	Country	Users	% Users
1.	India	44,217	73.36%
2.	Pakistan	7,773	12.90%
3.	Bangladesh	3,507	5.82%
4.	Nepal	547	0.91%
5.	Philippines	512	0.85%
6.	South Africa	394	0.65%
7.	United States	373	0.62%
8.	Indonesia	217	0.36%
9.	Myanmar (Burma)	193	0.32%
10.	Sri Lanka	179	0.30%

	Language	Users	% Users
1.	en-us	35,695	58.98%
2.	en-gb	15,040	24.85%
3.	en-in	5,657	9.35%
4.	hi-in	966	1.60%
5.	en-au	452	0.75%
6.	in-id	219	0.36%
7.	en-za	208	0.34%
8.	en-ph	155	0.26%
9.	pt-br	138	0.23%
10.	zh-cn	133	0.22%

Figure E.16. Blind Cricket top 10 user country locations and device primary language on Android (15 April 2016 – 16 June 2018) (Google Analytics).

	Country	Users	% Users
1.	United States	1,288	25.37%
2.	India	556	10.95%
3.	Australia	533	10.50%
4.	United Kingdom	442	8.71%
5.	New Zealand	314	6.18%
6.	Pakistan	230	4.53%
7.	Germany	126	2.48%
8.	South Korea	124	2.44%
9.	South Africa	102	2.01%
10.	Canada	85	1.67%

	Language	Users	% Users
1.	en-us	1,370	27.16%
2.	en-gb	557	11.04%
3.	en-au	529	10.49%
4.	en-in	460	9.12%
5.	en-nz	253	5.01%
6.	en-pk	167	3.31%
7.	en	138	2.74%
8.	ko-kr	121	2.40%
9.	de-de	108	2.14%
10.	en-za	90	1.78%

Figure E.17. Blind Cricket top 10 user country locations and device primary language on iOS (15 April 2016 – 16 June 2018) (Google Analytics).

The majority of Android downloads of *Blind Cricket* came from India (73.36%), Pakistan (12.9%) and Bangladesh (5.82%). This may indicate that blind cricket, as a sport, is very popular in these countries. Interestingly, only 1.6% of devices used Hindi as the primary language.

On the iOS platform, most downloads came from the US, which could mean that iOS devices are more popular in developed countries. There is a significant difference between the number of *Blind Cricket* downloads on Android (60,113) and on iOS (4,988) (see Table 7.4).

The data from 15 May 2018 was collected using Firebase Analytics and relates to version 2.2 of *Audio Game Hub* (see Figure E.11). Almost half of all downloads on the iOS platform came from the US. The Android version was most popular in India, the US and Pakistan.

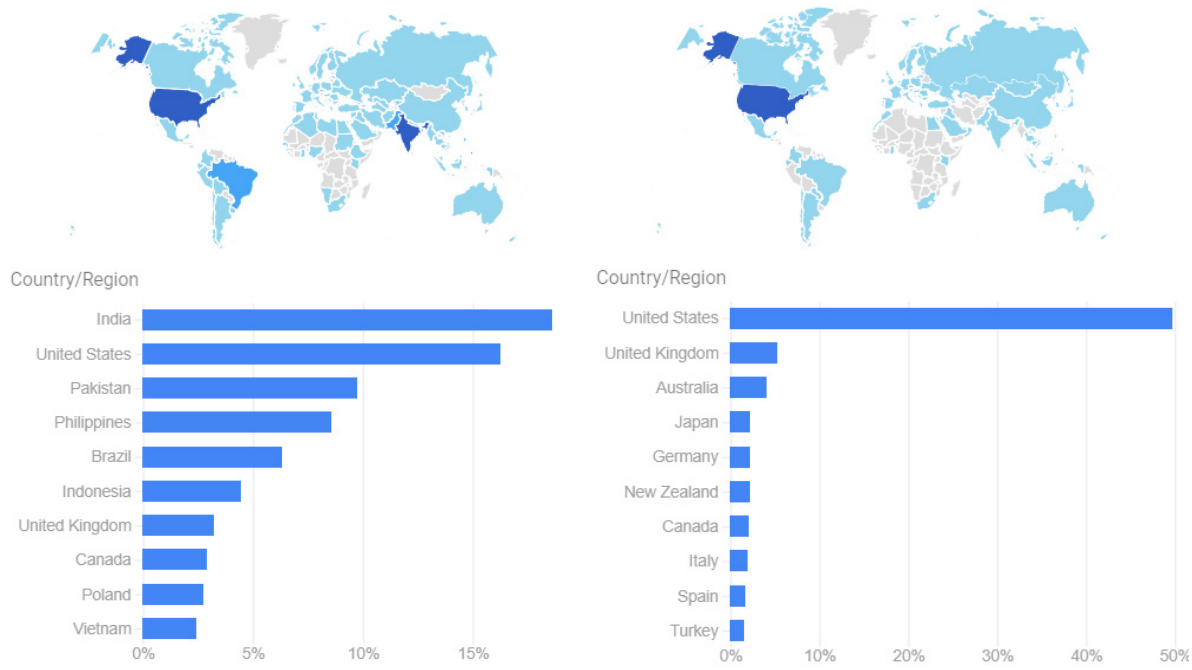


Figure E.18. Audio Game Hub 2.2 top 10 user country locations on Android (left) and iOS (right) (15 May 2018 – 16 June 2018) (Firebase Analytics).

Gender, age and blindness

Firebase Analytics data shows that the majority of the *Audio Game Hub* players are male (77.2% on Android and 65.1% on iOS) (see Figure E.12). The age distribution is similar on both platforms. More than 50% of users were aged between 18-34. However, there are more gamers aged 55 plus on iOS than on Android. Surprisingly, there are almost no female players aged 55 to 64 on the Android platform.

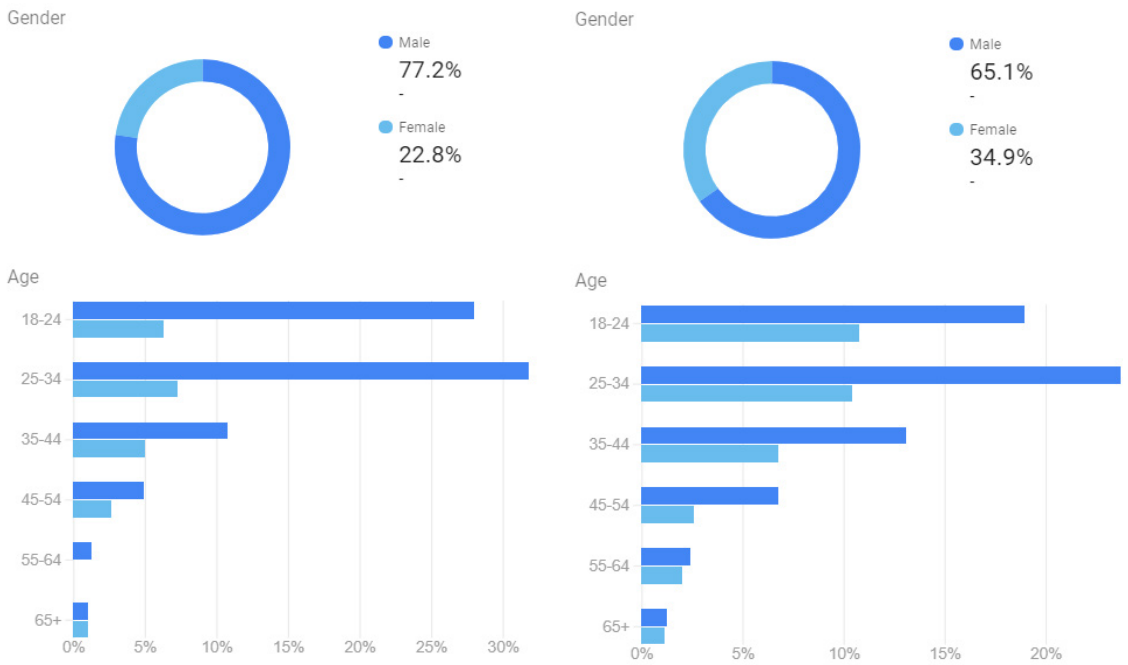


Figure E.19. Audio Game Hub 2.2 user gender and age distribution on Android (left) and iOS (right) (15 May 2018 – 16 June 2018) (Firebase Analytics).

Similar results were obtained using Facebook Analytics, although they were limited to players who used the Facebook Share function inside the application (18,771 users on both platforms) (see Figures E.13 and E.14). Unlike Firebase Analytics, one of the advantages of Facebook Analytics was that it also collected data about users between the ages of 13 and 17. Users whose age information cannot be verified or when there are not enough people in a demographic breakdown are categorised as 'Unknown'. Gender distribution data for *Blind Cricket* shows a significant disproportion between male (60.3%) and female (9.2%) players.

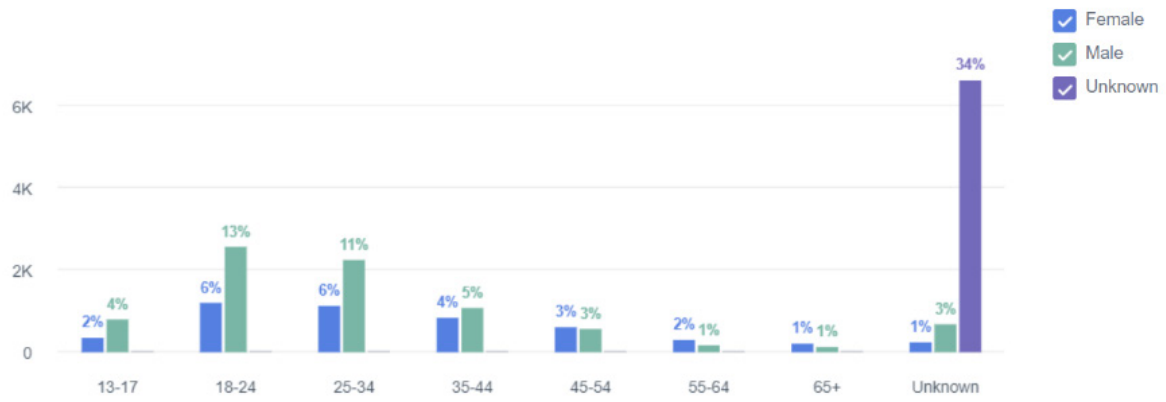


Figure E.20. User gender and age distribution of *Audio Game Hub* and Facebook users (31 May 2017 – 16 June 2018) (Facebook Analytics).

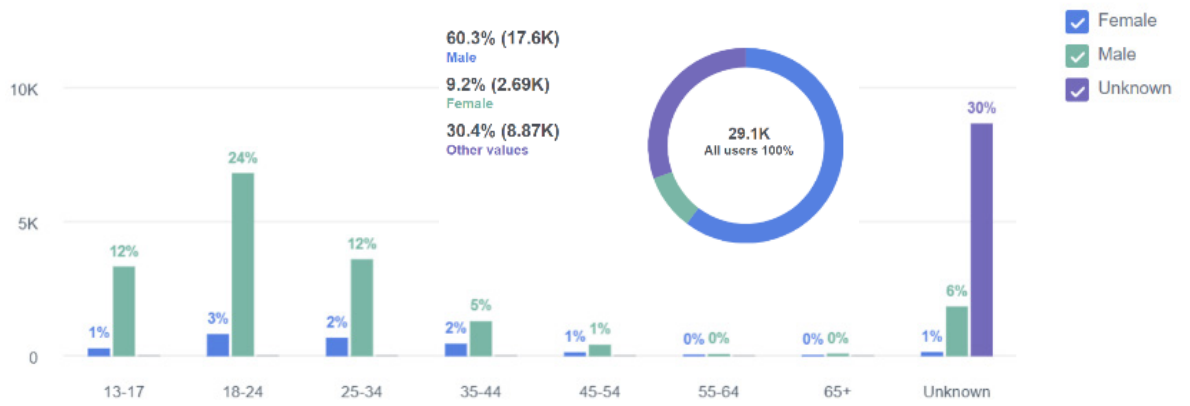


Figure E.21. User gender and age distribution of *Blind Cricket* and Facebook users (1 February 2017 – 16 June 2018) (Facebook Analytics).

We managed to distinguish between sighted and non-sighted users by creating a custom event called 'Sight Check'. This event was launched only once, at the very start of the application, and was presented as a large circular button displaying the text 'Touch me'. To diminish the risk of accidental touches by legally blind users, the button would appear in random places on the screen. However, this was not an accurate way to check the proportion of blind and sighted players. The *Audio Game Hub* sight check results were also influenced by the Brazilian YouTuber, whose audience was most likely sighted users. The *Blind Cricket* statistics might indicate incorrect Sight Check event implementation (nearly 100% non-sighted users, according to the data) (see Table E.2).

Table E.4
Summary of sighted and non-sighted users of Audio Game Hub and Blind Cricket games

	Platform	Number of users	Sighted	Non-sighted
Audio Game Hub	Android	39,093	27.08%	72.92%
	iOS	23,732	19.67%	80.33%
	Windows	4,124	16.72%	83.28%
Blind Cricket	Android	60,113	0.01%	99.99%
	iOS	4,988	0.00%	100.00%

User behaviour

Figure E.15 shows the median total time spent per user per day. For example, if a user spent three five-minute sessions interacting with an application throughout the day, then their time spent for that day was 15 minutes. The median time spent in the *Audio Game Hub* was

19.2 minutes and the median session length was 4.9 minutes. The median time spent in *Blind Cricket* was 4.8 minutes and the median session length was 4.7 minutes.

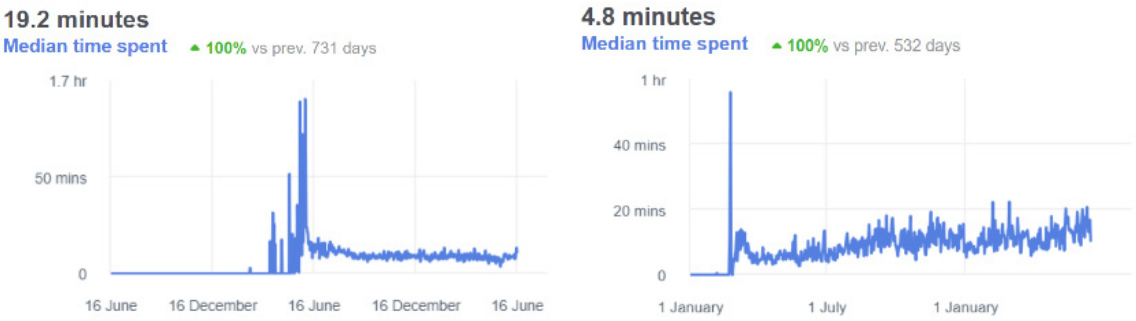


Figure E.22. Audio Game Hub (left) and *Blind Cricket* (right) daily user engagement of Facebook users (1 February 2017 – 16 June 2018) (Facebook Analytics).

Figure E.16 presents the most popular games in the *Audio Game Hub* on Android and iOS platforms. The most popular were *Archery*, *Hunt* and *Slot Machine*.

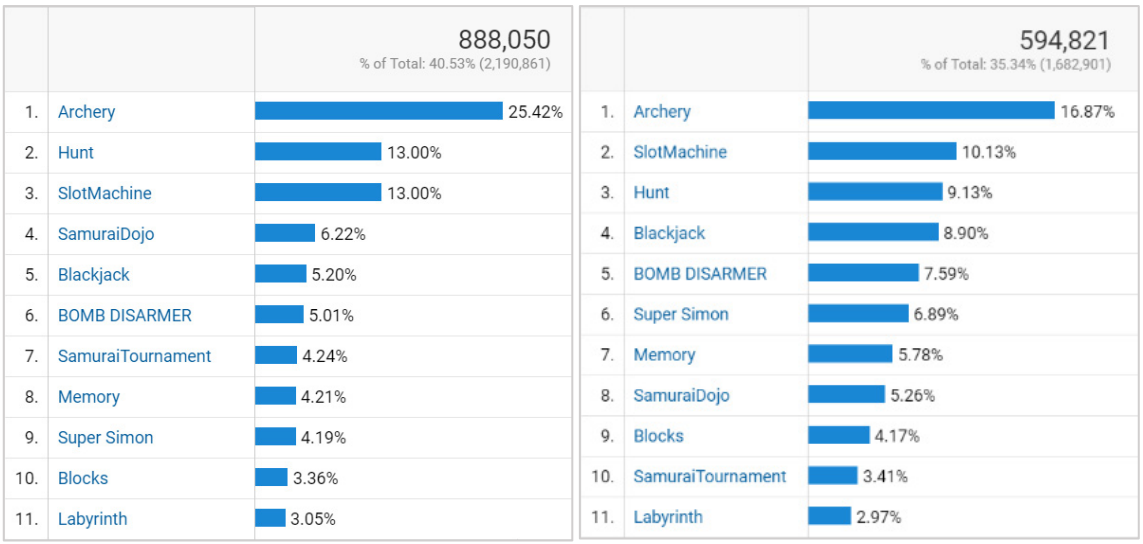


Figure E.23. Most popular games in *Audio Game Hub* on Android (left) and iOS (right) (16 April 2016 – 16 June 2018) (Google Analytics).

Figures E.17 and E.18 illustrate tracked events in *Audio Game Hub* on Android and iOS platforms. The most popular events were viewing advertisements (over 50%), sight check and changing graphics mode (normal, inverted or blind modes).

		184,153 % of Total: 100.00% (184,153)	184,153 % of Total: 100.00% (184,153)
1.	Advertisement Video Admob	84,243	45.75%
2.	Sight Check	41,299	22.43%
3.	SightCheck	10,720	5.82%
4.	Advertisement Unity	10,280	5.58%
5.	Changed graphic option to:	7,361	4.00%
6.	Attemp Purchase	7,238	3.93%
7.	InfoManager	4,936	2.68%
8.	Changed font size to:	4,736	2.57%
9.	Changed vibration	2,849	1.55%
10.	IAP User Cancelled	2,775	1.51%
11.	Changed read card suit option to:	2,238	1.22%
12.	Purchase Failed.	2,073	1.13%
13.	Played info	1,956	1.06%
14.	Shared on facebook.	1,006	0.55%
15.	Purchase Successful	443	0.24%

Figure E.24. Most popular events in *Audio Game Hub* on Android. (16 April 2016 – 16 June 2018) (Google Analytics).

		162,684 % of Total: 100.00% (162,684)	162,684 % of Total: 100.00% (162,684)
1.	Advertisement Video Admob	72,245	44.41%
2.	Sight Check	20,200	12.42%
3.	Advertisement Unity	13,410	8.24%
4.	Changed graphic option to:	10,309	6.34%
5.	SightCheck	9,102	5.59%
6.	Changed font size to:	7,591	4.67%
7.	Attemp Purchase	7,148	4.39%
8.	InfoManager	5,290	3.25%
9.	Changed vibration	4,069	2.50%
10.	Changed read card suit option to:	3,590	2.21%
11.	Played info	2,787	1.71%
12.	Purchase Failed.	2,224	1.37%
13.	Purchase Successful	2,067	1.27%
14.	IAP User Cancelled	1,840	1.13%
15.	Shared on facebook.	812	0.50%

Figure E.25. Most popular events in *Audio Game Hub* on iOS. (16 April 2016 – 16 June 2018) (Google Analytics).

Figures E.19 and E.20 indicate the most popular events in *Blind Cricket* on Android and iOS platform. Due to an implementation error, we have not tracked advertisements events.

		477,793 % of Total: 16.84% (2,836,575)	477,793 % of Total: 16.84% (2,836,575)
1.	Started careers mode	127,892	26.77%
2.	SightCheck	60,264	12.61%
3.	Lost at school level	55,093	11.53%
4.	Completed school level	40,046	8.38%
5.	Lost at school level by hitting wickets	29,855	6.25%
6.	Completed domestic level	29,017	6.07%
7.	Completed international level	24,282	5.08%
8.	In App Purchase	24,083	5.04%
9.	Changed graphic option to:	23,453	4.91%
10.	Changed font size to:	13,863	2.90%
11.	Changed vibration	8,245	1.73%
12.	InfoManager	8,032	1.68%
13.	Played info	6,831	1.43%
14.	Advertisement Unity	6,103	1.28%
15.	Lost at domestic level	5,451	1.14%
16.	Shared on facebook.	5,400	1.13%
17.	Lost at domestic level by hitting wickets	4,950	1.04%
18.	Lost at international level	2,486	0.52%
19.	Lost at international level by hitting wickets	2,259	0.47%
20.	Advertisement Interstitial	174	0.04%

Figure E.26. Most popular events in *Blind Cricket* on Android (2 February 2017 – 16 June 2018) (Google Analytics).

		106,598 % of Total: 15.66% (680,587)	106,598 % of Total: 15.66% (680,587)
1.	Started careers mode	26,823	25.16%
2.	Completed school level	11,113	10.43%
3.	Lost at school level	10,243	9.61%
4.	Completed domestic level	8,305	7.79%
5.	Completed international level	7,026	6.59%
6.	Changed graphic option to:	6,467	6.07%
7.	Lost at school level by hitting wickets	6,262	5.87%
8.	SightCheck	4,945	4.64%
9.	In App Purchase	4,758	4.46%
10.	Advertisement Unity	3,762	3.53%
11.	Changed font size to:	3,153	2.96%
12.	Shared on facebook.	2,678	2.51%
13.	Changed vibration	2,441	2.29%
14.	InfoManager	2,333	2.19%
15.	Played info	1,570	1.47%
16.	Lost at domestic level	1,506	1.41%
17.	Lost at domestic level by hitting wickets	1,364	1.28%
18.	Advertisement Interstitial	648	0.61%
19.	Lost at international level	603	0.57%
20.	Lost at international level by hitting wickets	598	0.56%

Figure E.27. Most popular events in *Blind Cricket* on iOS (2 February 2017 – 16 June 2018) (Google Analytics).

User devices

Figures E.21 to E.26 illustrate the most popular user device models and device brands for the *Audio Game Hub* and *Blind Cricket* on Android and iOS. About 80% of Apple users played games on smartphone (iPhone devices) and more than 16% played on tablets (iPad devices). The most popular Android phone was a Motorola Moto G3 (4.22% for *Audio Game Hub*) and Samsung Galaxy J2 (5.36% for *Blind Cricket*). The most popular device brand on Android platform was the Samsung (47.07% *Audio Game Hub* and 32.90% *Blind Cricket*).

		38,896 % of Total: 99.50% (39,093)	38,896 % of Total: 99.50% (39,093)
1.	(not set)	2,906	7.41%
2.	Motorola MotoG3	1,656	4.22%
3.	Samsung SM-J500M Galaxy J5	1,136	2.90%
4.	Motorola XT1069 Moto G (2nd Gen)	852	2.17%
5.	Motorola Moto G (4) Moto G4	766	1.95%
6.	Samsung SM-J200G Galaxy J2 (2015)	714	1.82%
7.	Motorola XT1033 Moto G	677	1.73%
8.	Motorola XT1068 Moto G (2nd Gen)	554	1.41%
9.	Samsung SM-G531H Galaxy Grand Prime	529	1.35%
10.	Motorola XT1505 Moto E (2nd Gen)	516	1.32%

Figure E.28. The most popular device models in *Audio Game Hub* on Android (16 April 2018 – 16 June 2018) (Google Analytics).

		38,896 % of Total: 99.50% (39,093)	38,896 % of Total: 99.50% (39,093)
1.	Samsung	18,515	47.07%
2.	Motorola	7,595	19.31%
3.	(not set)	2,906	7.39%
4.	LG	2,263	5.75%
5.	Asus	1,015	2.58%
6.	Lenovo	912	2.32%
7.	Sony	750	1.91%
8.	Huawei	708	1.80%
9.	Xiaomi	647	1.64%
10.	Google	413	1.05%

Figure E.29. The most popular device brands in *Audio Game Hub* on Android (16 April 2018 – 16 June 2018) (Google Analytics).

		23,363 % of Total: 98.45% (23,732)	23,363 % of Total: 98.45% (23,732)
1.	Apple iPhone	18,468	79.15%
2.	Apple iPad	4,316	18.50%
3.	Apple iPod Touch	550	2.36%

Figure E.30. The most popular device type in *Audio Game Hub* on iOS (16 April 2018 – 16 June 2018) (Google Analytics).

		60,113 % of Total: 100.00% (60,113)	60,113 % of Total: 100.00% (60,113)
1.	(not set)	6,092	10.16%
2.	Samsung SM-J200G Galaxy J2 (2015)	3,213	5.36%
3.	Samsung SM-J210F Galaxy J2 (2016)	2,137	3.56%
4.	Samsung SM-G550FY On5	922	1.54%
5.	Motorola MotoG3	866	1.44%
6.	Xiaomi Redmi Note 4	770	1.28%
7.	Samsung SM-J700F Galaxy J7	746	1.24%
8.	LG LG-K332 K7	676	1.13%
9.	Samsung SM-G610F J7 Prime	674	1.12%
10.	OPPO A33f	669	1.12%

Figure E.31. The most popular device models in *Blind Cricket* on Android (2 February 2017 – 16 June 2018) (Google Analytics).

		60,113 % of Total: 100.00% (60,113)	60,113 % of Total: 100.00% (60,113)
1.	Samsung	19,737	32.90%
2.	(not set)	6,092	10.16%
3.	Motorola	4,220	7.04%
4.	Micromax	3,726	6.21%
5.	Xiaomi	3,024	5.04%
6.	Vivo	2,604	4.34%
7.	Lenovo	2,536	4.23%
8.	LYF	2,144	3.57%
9.	OPPO	1,921	3.20%
10.	QMobile	1,376	2.29%

Figure E.32. The most popular device brands in *Blind Cricket* on Android (2 February 2017 – 16 June 2018) (Google Analytics).

		4,988 % of Total: 100.00% (4,988)	4,988 % of Total: 100.00% (4,988)
1.	Apple iPhone	4,058	81.31%
2.	Apple iPad	828	16.59%
3.	Apple iPod Touch	105	2.10%

Figure E.33. The most popular device type in *Blind Cricket* on iOS (2 February 2017 – 16 June 2018) (Google Analytics).

Website analytics

Google Analytics was used to record user activity on the website. During the website launch and the termination of data collection (21 April 2016 – 16 June 2018), www.audiogamehub.com was visited by 41,404 users and viewed 105,119 times (see Figures E.27 and E.29). The average session duration was one minute and 16 seconds. A high bounce rate was recorded. Bounce rate refers to the percentage of single-page sessions in which there is no interaction with the page (the user closed the website).

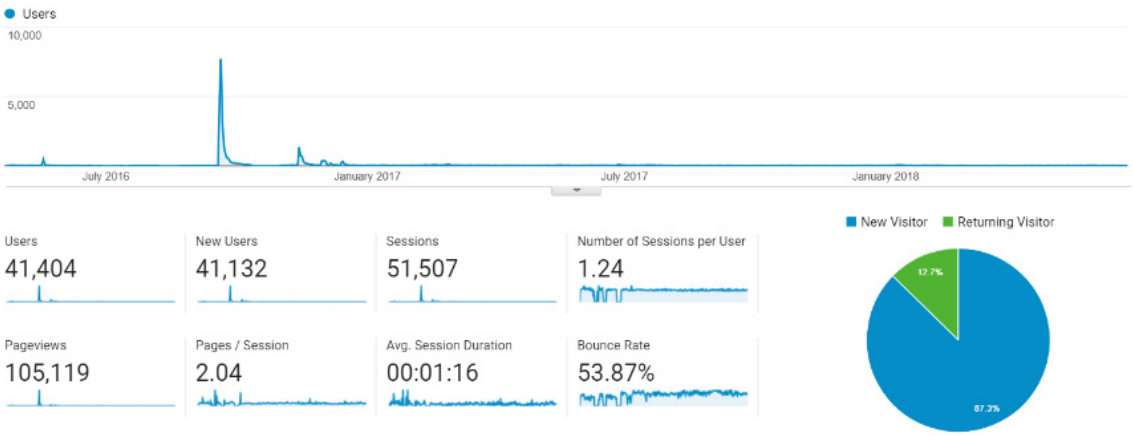


Figure E.34. User overview screen for www.audiogamehub.com website (21 April 2016 – 16 June 2018) (Google Analytics).

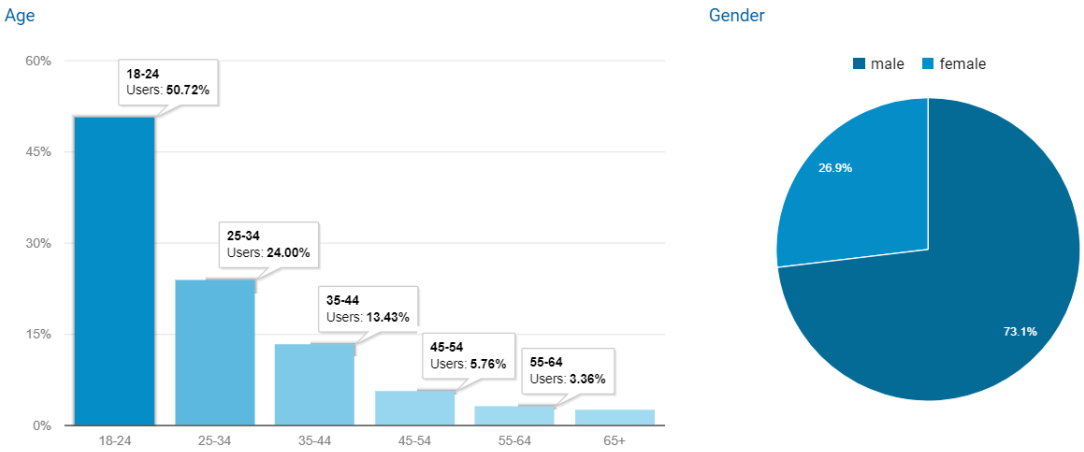


Figure E.35. Project website user gender and age distribution (15 May 2018 – 21 June 2018) (Google Analytics).

The gender distribution of users of the website was similar to mobile applications: 26.9% of users were female and 73.1% male (see Figure E.12 and E.28). There was a significant difference in age distribution: over 50% of visitors were aged between 18–24, and 24% aged between 25–34.

Most of the website visits came from Brazil (63.39%); again, probably attributable to the help of YouTuber Coisa de Nerd (Figure E.29).

Country	Users	New Users	Sessions	Bounce Rate
	41,404 % of Total: 100.00% (41,404)	41,132 % of Total: 100.00% (41,132)	51,507 % of Total: 100.00% (51,507)	53.87% Avg for View: 53.87% (0.00%)
1. Brazil	**26,121** (63.39%)	26,009 (63.23%)	30,877 (59.95%)	53.59%
2. United States	**2,672** (6.48%)	2,685 (6.53%)	3,609 (7.01%)	62.18%
3. Portugal	**2,535** (6.15%)	2,537 (6.17%)	2,908 (5.65%)	69.84%
4. Russia	**2,430** (5.90%)	2,444 (5.94%)	3,098 (6.01%)	8.10%
5. India	**1,005** (2.44%)	1,007 (2.45%)	1,472 (2.86%)	66.30%
6. Poland	**824** (2.00%)	826 (2.01%)	1,232 (2.39%)	50.00%
7. New Zealand	**706** (1.71%)	706 (1.72%)	1,432 (2.78%)	57.19%
8. United Kingdom	**536** (1.30%)	539 (1.31%)	729 (1.42%)	61.45%
9. Germany	**273** (0.66%)	278 (0.68%)	404 (0.78%)	58.17%
10. Canada	**259** (0.63%)	260 (0.63%)	313 (0.61%)	69.01%

Figure E.36. Project website top 10 user country locations (21 April 2016 – 16 June 2018) (Google Analytics).

Figures E.30 and E.31 illustrate user acquisition channels (how users discover the website). The most common was the use of a direct channel (user input the website address), accounting for 54.9% of all traffic. The second was an organic search, 29.7% (users found the website in the Google search engine). The third was through social media[249] channels, 9.6%. The fourth was via referrals[250] (links from other websites), 5.7%.

	Acquisition			Behavior		
	Users ↓	New Users	Sessions	Bounce Rate	Pages / Session	Avg. Session Duration
	41,404	41,132	51,507	53.87%	2.04	00:01:16
1 Direct	23,393			54.77%		
2 Organic Search	12,656			57.99%		
3 Social	4,106			46.43%		
4 Referral	2,449			37.39%		
5 Email	6			100.00%		

Figure E.37. Project website top acquisition channels (21 April 2016 – 16 June 2018) (Google Analytics).

Source / Medium	Acquisition			Behavior		
	Users ↓	New Users	Sessions	Bounce Rate	Pages / Session	Avg. Session Duration
	41,404 % of Total: 100.00% (41,404)	41,132 % of Total: 100.00% (41,132)	51,507 % of Total: 100.00% (51,507)	53.87% Avg for View: 53.87% (0.00%)	2.04 Avg for View: 2.04 (0.00%)	00:01:16 Avg for View: 00:01:16 (0.00%)
1. (direct) / (none)	**23,393** (54.78%)	23,487 (57.10%)	29,290 (56.87%)	54.77%	2.08	00:01:15
2. google / organic	**12,294** (28.79%)	11,384 (27.68%)	13,956 (27.10%)	57.90%	2.07	00:01:15
3. youtube.com / referral	**1,692** (3.96%)	1,653 (4.02%)	2,042 (3.96%)	78.45%	1.46	00:00:50
4. reddit.com / referral	**862** (2.02%)	851 (2.07%)	965 (1.87%)	2.07%	2.04	00:01:02
5. twitter.com / referral	**664** (1.55%)	640 (1.56%)	762 (1.48%)	0.13%	2.05	00:01:33
6. wykop.pl / referral	**551** (1.29%)	550 (1.34%)	577 (1.12%)	48.18%	1.29	00:00:44
7. motherboard.vice.com / referral	**519** (1.22%)	429 (1.04%)	533 (1.03%)	0.38%	2.02	00:01:02
8. facebook.com / referral	**399** (0.93%)	100 (0.24%)	446 (0.87%)	43.95%	2.98	00:01:50
9. lifehacker.com / referral	**317** (0.74%)	315 (0.77%)	345 (0.67%)	0.00%	2.09	00:01:17
10. m.facebook.com / referral	**221** (0.52%)	210 (0.51%)	234 (0.45%)	79.91%	1.31	00:00:36

Figure E.38. Project website top 10 sources[251] of traffic (21 April 2016 – 16 June 2018) (Google Analytics).

[249] Here, the biggest impact came from YouTube (41.21%), Reddit (20.96%), Facebook (19.67%) and Twitter (17.51%).
[250] Here the biggest impact came from www.wykop.pl (21.75%), www.motherboard.vice.com (20.46%), www.lifehacker (12.50%) and www.audiogames.net (5.44%).
[251] The Source is the place (website) where users were before coming to a target website. The Medium describes how users arrived at the website.

Revenue

Along with the *Audio Game Hub 2.0* and *Blind Cricket*, we implemented monetisation mechanisms in order to evaluate the games' revenue potential (see Figures E.32 to E.44). These mechanisms include in-app purchases and advertisements as explained in Section 4.4. What is important to note is that for applications and in-app products that are sold via Apple and Google the transaction fee was equivalent to 30% of the price. This means that the application developer effectively received 70% of the revenue. In Table E.3, iOS revenues were converted from USD to NZD at the exchange rate of 1 USD equals 1.44 NZD (as at 18 June 2018).

Table E.5
Summary of revenue and pay-outs for the Audio Game Hub and Blind Cricket split across platforms (15 April 2016 – 16 June 2018)

	Platform	Users	Revenue (NZD)	Pay-out (NZD)
Audio Game Hub	Android	39,093	5,390.33	3,802.09
	iOS	23,732	27,867.00	19,615.80
	PC Windows	4,124	0.00	0.00
Blind Cricket	Android	60,113	754.54	533.32
	iOS	4,988	4,114.60	2,930.92
TOTAL		132,050	38,126.47	26,882.13

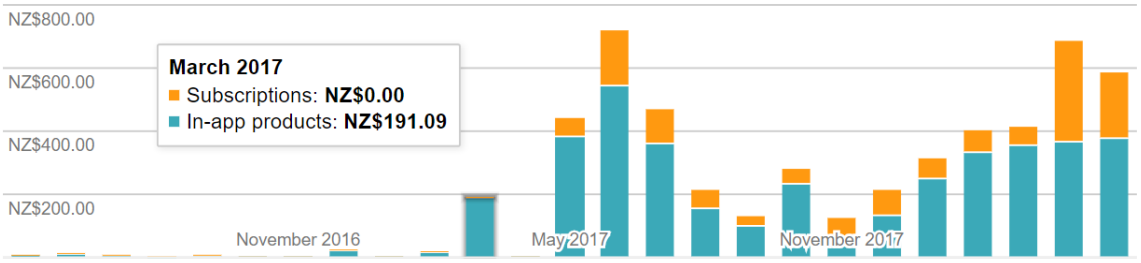


Figure E.39. Monthly breakdown of revenue for the *Audio Game Hub* on Android (2 June 2017 – 18 June 2018) (Google Play).

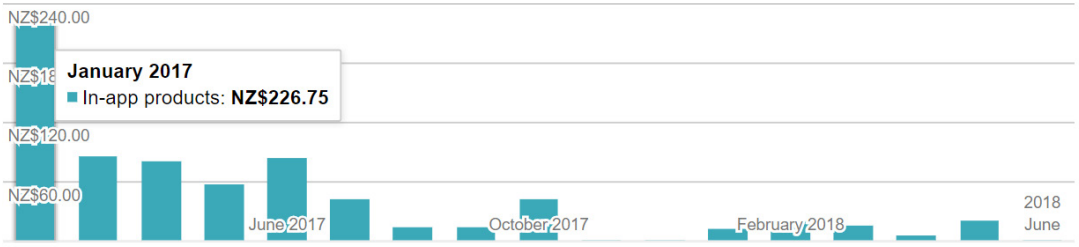


Figure E.40. Monthly breakdown of revenue for *Blind Cricket* on Android (1 January 2017 – 18 June 2018) (Google Play).

In-app product		Revenue	Orders	Refunds
1000 Coins		NZ$1,329.31	445	0
9 Games Pack		NZ$922.29	27	1
50,000 Coins		NZ$464.89	34	1
10,000 Coins		NZ$322.54	37	0
100 Dollars		NZ$187.10	1	0
Archery		NZ$104.34	25	0
5 Dollars		NZ$87.72	11	0
Bomb Disarmer		NZ$86.50	12	0
Super Simon		NZ$71.69	10	0
Hunt		NZ$66.89	16	0
Animal Escape		NZ$63.91	7	0
10 Dollars		NZ$62.80	4	0
10 random sound packs		NZ$62.37	41	1
Blocks		NZ$16.83	4	0
1 Dollar		NZ$14.27	10	0
Memory		NZ$13.44	3	0
Samurai Tournament		NZ$12.65	3	0
Labyrinth		NZ$8.33	2	0
Samurai Dojo		NZ$8.25	2	0
In-app products total		NZ$3,906.12	694	3

Figure E.41. Breakdown of in-app purchases revenue for the *Audio Game Hub* on Android (2 June 2017 – 18 June 2018) (Google Play).

Subscription	Revenue	New	Cancelled	Active on 16/06/18
All Game Access 1 Month	**NZ$745.89**	26	21	5
Access to all games for 12 months	**NZ$401.28**	8	2	6
All Game Access 12 Month	**NZ$115.90**	6	4	2
All Game Access 6 Month	**NZ$103.28**	5	2	3
Access to all games for 3 months	**NZ$21.66**	2	1	1
Subscriptions total	**NZ$1,388.01**	47	30	17

Figure E.42. Breakdown of subscription revenue for the *Audio Game Hub* on Android (2 June 2017 – 18 June 2018) (Google Play).

In-app product	Revenue	Orders	Refunds	Unique buyers
Buy Cricket Game - 5 USD	**NZ$536.83**	74	0	0
Buy Cricket Game and donate - 10$	**NZ$71.38**	5	0	0
Buy Cricket Game and donate - 50 USD	**NZ$70.55**	1	0	0
Donate 5$	**NZ$58.64**	8	0	0
In-app products total	**NZ$737.40**	88	0	0

Figure E.43. Breakdown of in-app purchases revenues of *Blind Cricket* on Android (1 January 2017 – 18 June 2018) (Google Play).

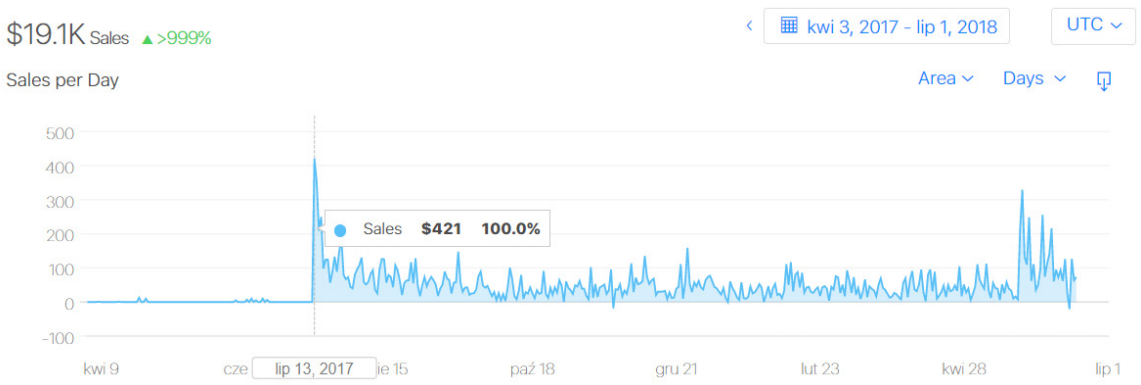


Figure E.44. Daily breakdown of in-app purchases revenue for the *Audio Game Hub* on iOS (15 April 2016 – 18 June 2018) (App Store Connect).

	Name	Type	Platforms	Apple ID	Sales (USD)
1	9 Games Pack - Full Price (Audio Game Hub)	In App	iOS	1237056228	$4.82K
2	50,000 Coins - Full Price (Audio Game Hub)	In App	iOS	1237056022	$4.80K
3	All Game Access 1 month - Full Price (Audio Game Hub)	In App	iOS	1237057020	$2.26K
4	10,000 Coins - Full price (Audio Game Hub)	In App	iOS	1237054824	$1.32K
5	All Game Access 12 months new price (Audio Game Hub)	In App	iOS	1387019754	$1.27K
6	1,000 Coins (Audio Game Hub)	In App	iOS	1237055187	$983
7	All Game Access 12 Months - Full Price (Audio Game Hub)	In App	iOS	1237060779	$534
8	Animal Escape (Audio Game Hub)	In App	iOS	1364728291	$468
9	Archery - Full Price (Audio Game Hub)	In App	iOS	1237062367	$375
10	Bomb Disarmer - Full Price (Audio Game Hub)	In App	iOS	1237065472	$332
11	All Game Access 6 Months - Full Price (Audio Game Hub)	In App	iOS	1237061790	$300
12	Hunt - Full Price (Audio Game Hub)	In App	iOS	1237063166	$274
13	10 Random Sound Packs (Audio Game Hub)	In App	iOS	1247418369	$272
14	Super Simon - Full Price (Audio Game Hub)	In App	iOS	1237066256	$271
15	Access to all games for 3 months (Audio Game Hub)	In App	iOS	1387014091	$157
16	Donation_5 (Audio Game Hub)	In App	iOS	1108740856	$119
17	Blocks - Full Game (Audio Game Hub)	In App	iOS	1237065308	$113
18	Donation_50 (Audio Game Hub)	In App	iOS	1244329103	$112
19	Donation_10 (Audio Game Hub)	In App	iOS	1108741071	$105
20	Memory - Full Price (Audio Game Hub)	In App	iOS	1237063951	$92.28
21	Samurai Tournament - Full Game (Audio Game Hub)	In App	iOS	1237063594	$62.73
22	Labyrinth - Full Price (Audio Game Hub)	In App	iOS	1237064207	$57.26
23	Samurai Dojo - Full Price (Audio Game Hub)	In App	iOS	1237063940	$47.15
24	Donation_1 (Audio Game Hub)	In App	iOS	1108740775	$2.06

Figure E.45. Breakdown of in-app purchases revenue for the *Audio Game Hub* on iOS (15 April 2016 – 18 June 2018) (App Store Connect).

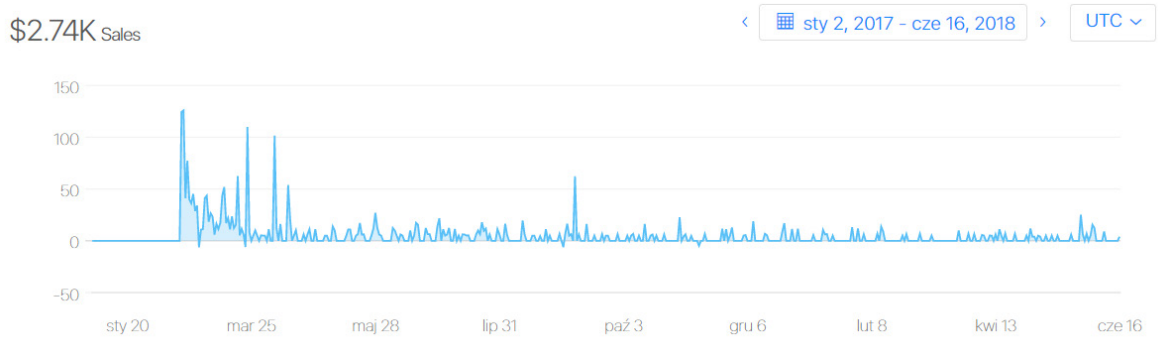


Figure E.46. Daily breakdown of in-app purchases revenue for *Blind Cricket* on iOS (1 February 2017 – 18 June 2018) (App Store Connect).

	Name	Type	Platforms	Apple ID	Sales (USD)
1	Buy Blind Cricket - 4.99 USD (Blind Cricket)	In App	iOS	1205375361	$1.94K
2	Buy Blind Cricket - 9.99 USD (Blind Cricket)	In App	iOS	1205375363	$303
3	Buy Blind Cricket - 99.99 USD (Blind Cricket)	In App	iOS	1205375986	$212
4	Donate 4.99 USD (Blind Cricket)	In App	iOS	1205376309	$112
5	Buy Blind Cricket - 49.99 USD (Blind Cricket)	In App	iOS	1205375985	$106
6	Donate 49.99 USD (Blind Cricket)	In App	iOS	1205376491	$55.68
7	Donate 9.99 USD (Blind Cricket)	In App	iOS	1205376310	$13.47

Figure E.47. Breakdown of in-app purchases revenue for *Blind Cricket* on iOS (1 February 2017 – 18 June 2018) (App Store Connect).

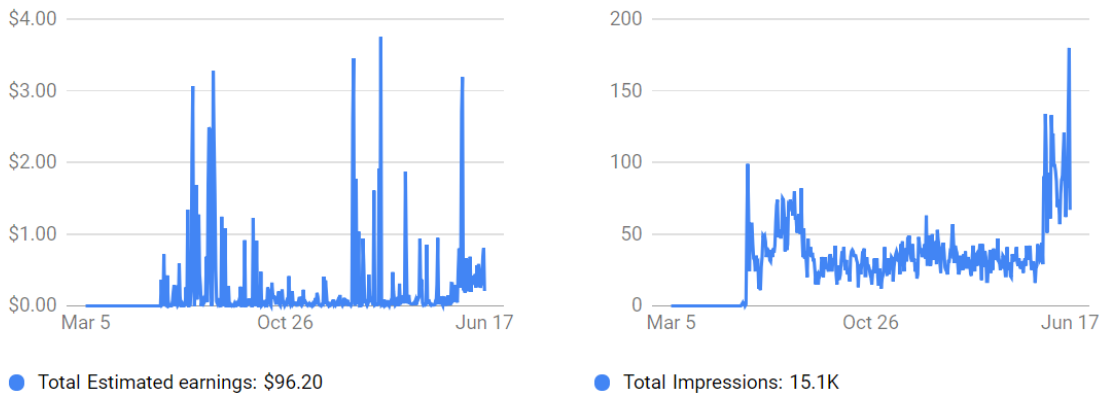


Figure E.48. Advertisement revenue of the *Audio Game Hub* on Android (1 February 2017 – 18 June 2018) (Admob).

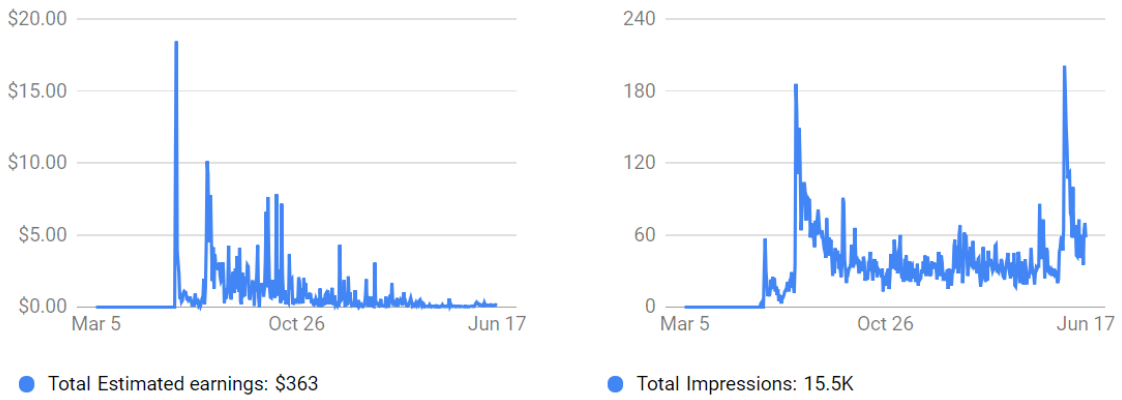


Figure E.49. Advertisement revenue for the *Audio Game Hub* on iOS (1 February 2017 – 18 June 2018) (Admob).

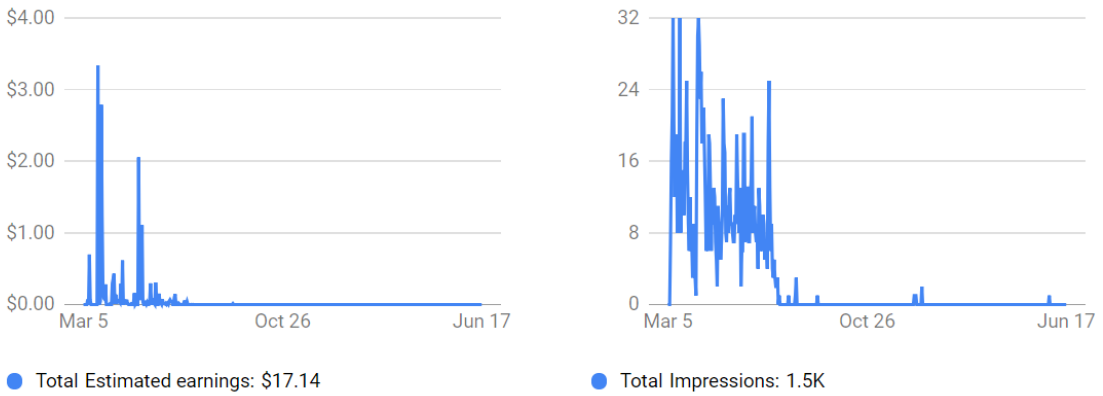


Figure E.50. Advertisement revenues for *Blind Cricket* on Android (1 February 2017 – 18 June 2018) (Admob).

Figure E.51. Advertisement revenues for *Blind Cricket* on iOS (1 February 2017 – 18 June 2018) (Admob).

Tables E.4 and E.5 summarise revenue generated by the *Audio Game Hub* across in-app purchase types. These comprise:

- consumables (coin packs for casino games and donations)
- non-consumables (purchasing all games packs, sound packs and each individual game. These purchases could be restored in the Restore Purchases menu)
- subscriptions (these afforded 12-, six-, three- and one-month full access to all of the games)
- advertisements.

Table E.6
Summary of revenue and pay-outs for the *Audio Game Hub* on Android divided across in-app purchase types (15 April 2016 – 16 June 2018)

	In-app type	Revenues (NZD)	Payout (NZD)	%
Android	Consumables	2,531.00	1,771.70	46.60%
	Non-consumables	1,375.12	962.58	25.32%
	Subscriptions	1,388.01	971.61	25.55%
	Advertisements	96.20	96.20	2.53%
TOTAL		5,390.33	3,802.09	100%

Table E.7. Summary of revenues and pay-outs for the *Audio Game Hub* on iOS divided across in-app purchase types (15 April 2016 – 16 June 2018).

	In-app type	Revenues (NZD)	Payout (NZD)	%
iOS	Consumables	11,106.81	7,774.76	39.64%
	Non-consumables	9,886.95	6,920.87	35.28%
	Subscriptions	6,510.24	4,557.17	23.23%
	Advertisements	363.00	363.00	1.85%
TOTAL		27,867.00	19,615.80	100%

On Android (Table E.4), most of the revenue came from consumables. These generated almost half of the total revenue (46.6%). Non-consumables and subscriptions were on a similar level (around 25% each). The revenue from advertisements was low that it could

probably be omitted. Their only purpose might have been to motivate users to buy full access to the games.

The iOS platform (Table E.5) showed similar results to Android. However, the total revenue on Android was over five times lower than on the iOS platform. Considering that the Android platform had almost twice as many users (39,093) as iOS (23,732), the revenue per user is almost nine times higher on iOS than on Android.

Awards and recognition

In the two years of its existence, the *Audio Game Hub* received multiple recognitions, nominations and awards. It also featured[252] twice on Apple App Store and once on Google Play Store (see Table E.6).

Table E.8
List of awards and recognitions for the Audio Game Hub

Date	Who	Recognition
07.05.2018	Google LLC	Best Accessibility Experience nomination at the Google Play Awards 2018.
18.11.2017	Wielka Gala Integracji	Highly Commended' at Wielka Gala Integracji – sponsored by the President of Poland, Warsaw, Poland.
19.10.2017	NZ Innovation Awards	Highly Commended at the NZ Innovation Awards 2017, Auckland, New Zealand.
23.11.2016	TechRadar	Ranked #13 in The Best Free iPhone Games in the World in 2016.
01.09.2016	RNIB	App of the Month award from the Royal National Institute of Blind People, United Kingdom.
23.04.2016	Play by Play Festival	Winner of the Representation Award at the Play by Play International Games Festival, Wellington, New Zealand.

Conferences

The *Audio Game Hub* concept, development progress and its results were presented at three conferences (see Table E.7).

[252] 'Featured' means that the application icon was displayed on their 'Staff picks' or 'Recommended' tabs.

Table E.9
List of conferences where the Audio Game Hub was presented

Date	Place	Name of conference
05–08 September 2017	Auckland, New Zealand	NZ Game Developers Conference 2017
24–26 August 2016	Katowice, Poland	Information Systems Development
09–10 April 2016	Auckland, New Zealand	New Zealand Computer Science Research Student Conference

Media coverage

The search term 'Audio Game Hub' in the Google search engine on 16 June 2018 returned 6,890 results. Table E.8 provides an overview of some of the media coverage that the *Audio Game Hub* and *Blind Cricket* games received, including online articles, podcasts, video reviews, blog posts, news and national television interviews.

Table E.10
Overview of media coverage relating to the Audio Game Hub and Blind Cricket

Date	Type	Author/Publisher	Title
25.04.2016	Podcast	iSee	Demo of the Audio Game Hub self voicing game for iOS
21.05.2016	Podcast	PG13 Plays	PG13 hunt the villains from beyond the Audio Game Hub
30.05.2016	Description	Game-accessibility.com	Audio Game Hub
21.06.2016	News	Idealog.co.nz	Listen up: A game both the sighted and blind can play together
09.11.2016	News	AUT University	From AUT student to award-winning entrepreneur
16.11.2016	News	Game Planet	Auckland Students Build Games for the Visually Impaired, Find Crowdfunding Success
16.11.2016	News	NZ Game Developers Association	Audio Game Hub – Keep your ears wide open
20.11.2016	Blog	One Angry Gamer	Auckland Game Hub seek to expand games for visually impaired gamers
21.11.2016	News	Stuff.co.nz	Gaming app for the visually impaired puts audio before video

Date	Type	Author/Publisher	Title
22.11.2016	Blog	Kill Screen	Taking on the responsibility of making games for the visually impaired
15.12.2016	News	iNews.co.uk	The ingenious way that video games are being played by the blind
15.12.2016	News	Newshub.co.nz	NZ-made video games for the blind getting global attention
21.01.2017	News	Stuff.co.nz	Still sledging at the Twenty20 Blind World Cup
21.01.2017	TV	TVNZ One	A video game for people who can't see.
11.02.2017	Article	Pcsgames.net	Fantastic Accessible iPhone Games and Where to Find Them!
09.03.2017	News	Metro Blind Sport	Audio Games: Blind Gamers Twenty 20 Cricket Game and More!
23.07.2017	Podcast	AppleVis	An introduction to Audio Game Hub 2 for iOS
19.10.2017	News	NZ Innovation Awards 2017	New Zealand Innovation Awards Finalists 2017
07.12.2017	Podcast	Tyflopodcast.com	Audio Game Hub
24.04.2018	News	Venturebeat.com	Google nominates 45 Android apps and games for the 2018 Play Awards
24.04.2018	Blog	Android Developers Blog	Time to celebrate the 2018 Google Play Award nominees
01.05.2018	Press release	Scoop.co.nz	Kiwi app Audio Game Hub selected for global nomination
01.05.2018	News	blindlowvision.org.nz	An app developed in the Blind Low Vision NZ Awhina House studios has been nominated for a top accessibility award
04.05.2018	News	Te Waha Nui	Kiwi app for the visually impaired scores global recognition
07.05.2018	TV	TV One	Interview on Breakfast TV
16.05.2018	Press release	Scoop.co.nz	Blind Foundation technology initiatives help people
23.05.2018	Podcast	Harmonica Payer Podcast	Audio Game Hub version two is out
28.05.2018	Article	Disability Horizons	10 fun accessible game and activity apps for disabled people
28.05.2018	Description	Audiogames.net	Audio Game Hub
29.05.2018	Review	Perkins School for the blind eLearning	Audio Game Hub App Review

Note: Click on the Author/Publisher to follow the source link.

Our games have also been reviewed by numerous YouTubers. On 18 June 2018, the search phrase 'audio game hub' returned over 900 results on YouTube. Table E.9 features an extract of YouTube videos with over 1,000 views. All these videos combined were viewed more than two million times.

Table E.11
List of YouTube videos about the Audio Game Hub and Blind Cricket with over 1,000 views as at 18 June 2018

Date	Views	YouTuber	Title
28.04.2016	1,602	dinalt	Audio Game HUB. iOS Gameplay
13.08.2016	2,671	IllegallySighted	IOS Accessible Game Spotlight – Audio Game Hub
18.09.2016	1,481,129	Coisa de Nerd	JOGO PRA CEGO? – (Game for blind?)
13.11.2016	413,570	Wuant	O DESAFIO CEGO (The Blind Challenge)
15.11.2016	171,497	Calango	O JOGO PARA CEGOS (The game for blind)
27.04.2017	1,531	Blind Help Project	How to play Blind Cricket: Demonstration and tutorial of Blind Cricket Game on iOS in English
17.08.2017	2,546	TapGameplay	Audio Game Hub – Gameplay

Because of reviews by two YouTubers—Coisa de Nerd and Wuant—the *Audio Game Hub* received a significant boost in downloads and user reviews. These reviews were organic (we did not request them).

Appendix F – Change log

This section outlines the *Audio Game Hub* and *Blind Cricket* dates, versions and implemented changes on the Android platform. Information about changes was copied directly from the Google Play Console and has been left in its original form. Information about changes was presented to users while they were updating the applications on their devices.

Audio Game Hub release dates, versions and changes on Android platform

Date	Version	Changes
26/05/2018	2.2.2	Small bugfixes. Added new links in More Games.
17/05/2018	2.2.1	Added new game Animal Escape! Fixed bug with settings graphics glitch. Fixed bug with news section - unable to close news after completion. Updated Google Play Games to latest version. Updated Facebook plugin to latest version. Added new achievements for Animal Escape. Buy all games and specific games purchases are no longer available (except Animal Escape). Users who have purchased any of games (or all games) before this update will keep them.
17/08/2017	2.1.5.1	Minor bug fix.
16/08/2017	2.1.5	Added new menu interface sounds.
09/08/2017	2.1.4	Improved High score text to speech reading. Added sound feedback to show how many elements are in the menu.
05/08/2017	2.1.3	Improved the way how the text to speech reads the high score. Added vibration feedback upon failing in Bomb Disarmer. Minor bug fixes.
25/07/2017	2.1.1	Fixed the news section. Memory gameplay improvements (increased the box size, graphical improvements). Added hover function on Back and Settings button. Minor bug fixes and improvements.

21/07/2017	2.1.0	Fixed the Hunt bug - now it is possible to hit the animals. Fixed the news section bug (now plays news correctly). Fixed the Inverted mode background - now displays correctly).
16/07/2017	2.0.9	Fixed the Bomb Disarmer tutorial bug. Fixed menu button animation.
07/07/2017	2.0.8g	Minor bug fix.
04/07/2017	2.0.8c	Added the new menu interface sounds. Fixed Labyrinth high score bug. Fixed Blackjack high score sorting order bug.
14/06/2017	2.0.7a	Minor bug fix
06/06/2017	2.0.5	Minor bug fix
05/06/2017	2.0.4	Minor bug fix
03/06/2017	2.0.3	Minor bug fix
03/06/2017	2.0.2	Minor bug fix
02/06/2017	2.0.1	3 brand new games: - Blackjack, - Super Simon, - Bomb Disarmer. 58 Achievements. Re-mastered menu system. Leader boards - for each game! Integrated news section. Scalable fonts. High contrast mode. Added casino games section. Performance optimisations. Euphoric music and 40+ sound packs for Simon game. Starting from version 2.0 games are paid. There is an option to play for free by watching advertisements. Blackjack and Slot Machines remain free games.
08/11/2016	1.1.7	Changed how the archery reads the score. Implemented a new feature in hunt where it gives the player a sound feedback if the player accidently goes off the screen. Fixed a rare bug in Samurai Tournament, where the round will restart randomly. Fixed various small bugs.
16/05/2016	1.1.6	High score system is online!
15/04/2016	1.0.0	First release.

Blind Cricket release dates, versions and changes on Android platform

Date	Version	Changes
06/07/2017	1.1.0	Cricket tutorial can be skipped by going back now. Added a new menu interface sounds.
20/04/2017	1.0.15	Minor bug fixes and performance optimisation.
31/03/2017	1.0.14	Fixed the menu crash upon returning from game.
31/03/2017	1.0.13	Fixed the menu crash upon returning from game.
22/03/2017	1.0.12	We detected multiple hacks and cheaters on our leader board. Therefore, we took steps to protect it. But, it had to be reset. This update will reset your high scores. Achievement and top supporters list are not changed. We have made changes to the support screen. Fixed delays on some of the voice overs. Watch an advertisement is optional and upon buying the game or supporting, it will be removed forever. Achievements will count towards the high score points.
13/03/2017	1.0.11	Minor bug fixes.
09/03/2017	1.0.10	Added free-to-play option by adding advertisements (Optional). Minor bug fixes.
03/03/2017	1.0.9	Minor bug fix.
16/02/2017	1.0.7	Fixed bug in achievements menu. Updated High scores - now showing 50 results. Added payments for the game - play career 1 time for free. Half of the payments will be donated to New Zealand's blind cricket team the Blind Caps. Added top supporters list.
15/02/2017	1.0.6	Added Support Us screen and Top supporters leader boards. Fixed return button in High scores. Fixed font error in High scores and Achievements.
13/02/2017	1.0.5	Fix leader board display bug. Add IAP.
04/02/2017	1.0.4	New High score system. Added transitions between career levels. Balanced difficulty levels.
03/02/2017	1.0.3	Tutorial fix.
03/02/2017	1.0.2	Updated screen logo.
03/02/2017	1.0.1	Updated screen logo.
03/02/2017	1.0	Blind Cricket release

Appendix G – *Audio Game Hub* and *Blind Cricket* credits

This section presents credits screens from the *Audio Game Hub* and *Blind Cricket* games indicating people involved in their production.

Audio Game Hub credits

Project lead Jarek Beksa

Design Jarek Beksa
Jeong Su Jeon
Sonia Fizek
David Sheele

Programming Jeong Su Jeon
Yiding Liu
Serge Vodanovich
David Sheele
Austin O'Brien
Sophie Jent

Sound design Jarek Beksa

Graphics Laleh Torabi
Austin O'Brien
Alex Garkavenko
Rafal Sadowski

Project website Alex Garkavenko
Juan Rodriguez
Jarek Beksa

Kickstarter campaign Jarek Beksa
David Delgado
Jeon Su Jeon
Juan Rodriguez
Vincent Polehwidhi
Tarn Tarn
Jin Hong
Reza Mohammad Yari

Voice recordings

Creative Sound Conception Studio Hamburg
The Sound Room
New Zealand's Blind Low Vision NZ Studios

Cast

Count	Armin Schwing
Croupier	Jennifer Sarah Boone
Factory Worker	Sarah Mcilwraith
Farmer	Colin Solman
Narrator	West Westbrook Simon Orange
Orderly	Joe Gillfilan
Dispatcher	Alex D'Attoma
Bomb Disarmer	Richard Durham
Joe the Driver	Eugene Upston Joe Gillfilan

Testers

Julie Woletz, Tomasz Tworek, Shaun Everis,
Joseph Weakland, Chantelle Griffits

Special thanks

Mathias Fuchs
Stephen MacDonell
Sonia Fizek
Phil Carter
Mitali Purohit
Steve Corbet
Phil Turner
Robert Wellington
Luke Sniewski

Able Gamers Foundation
AUT Enterprises Limited

Sonnar Interactive
2018

Blind Cricket credits

Project lead Jarek Beksa

Design Jarek Beksa
Peter McGlashan

Programming Jeong Su Jeon
Yiding Liu

Sound design Jarek Beksa

Graphics Rafał Sadowski

Kickstarter campaign Jin Hong
Reza Mohammad Yari

Voice recordings

Eugene Upston
New Zealand Blind Low Vision NZ Studios

Cast

Narrator Richard Durham
Coach Richard Durham
Commentator 1 Peter McGlashan
Commentator 2 Richard Durham

Testers

Tomasz Tworek, Shaun Everis,

Special thanks

Kickstarter supporters
AUT Enterprises Limited
Auckland University of Technology
Blind Caps Cricket Team New Zealand
James Dunn, Maia Lewis
Be Accessible
Able Gamers Foundation

Sonnar Interactive
2017

Appendix H – Individual team members' contributions

Name	Timeframe	Contribution
Jeong Su Jeon	08.2015 - present	Programmed over 95% of all games
Serge Vodanovich	08.2015 – 01.2016	Contributed to programming of *Audio Game Hub 1.0* menu interface, *Hunt* and *Labyrinth*
Austin O'Brien	08.2015 – 03.2016	*Audio Game Hub 1.0* animations and graphics
Alex Garkavenko	02.2016 – 08.2016	Designed and developed the project website
Tomasz Tworek	08.2016 – 04.2018	Testing
Mitali Purohit	06.2016 – 11.2017	Contributed to acquiring investment and funding
David Delgado	10.2016 - 01.2017	Created the Social Media, graphics and project description for the Kickstarter campaign
Juan Rodriguez	10.2016 - 02.2017	Worked on the on-line forum, graphics and support for Kickstarter campaign
Vincent Polehwidhi	10.2016 – 01.2017	Contributed to the Kickstarter campaign promotion
Tarn Tarn	10.2016 - 12.2017	Contributed to the Kickstarter campaign promotion
Jin Hong	10.2016 – 11.2016	Filming of the Kickstarter video
Reza Mohammad Yari	10.2016 - 11.2016	Filming of the Kickstarter video
Luke Sniewski	10.2016 – 11.2016	Editing of the Kickstarter video
Yiding Liu	12.2016 - 04.2017	Contributed to programming of in-app purchases, high scores, achievements and *Blind Cricket* game
Peter McGlashan	12.2016 – 02.2017	Voice acting and design of *Blind Cricket* gameplay, AUT event organizer
Eugene Upston	01.2017 – 03.2017	Sound design of *Animal Escape*
Richard Durham	01.2017 – 06.2017	Voice acting, design of achievements
Joe Gilfilan	01.2017 – 06.2018	Voice acting
Rafał Sadowski	01.2017 – 03.2017	Designed the graphics for *Blind Cricket*