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Faculty	School Computing
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Project Supervisor	Cathal Gurrin
Due Date	20th May 2019

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Open Eyes VR

Final Year Project Report

Prepared by:Aoibhin Laverty, 15311956 & Sean Williams, 15743859
May 2019

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1.Executive Summary

83% of second level student believe Virtual Reality will be commonplace in the next five years. Open Eyes VR aims to use Virtual Reality to enable colleges to market more effectively nationally and internationally. The student market is continuously growing at a steady rate with an average increase of 3% of undergraduates enrolling in college each year. There is a significant rise in the number of international students coming to Ireland to study and colleges struggle to showcase their campus and facilities to the international market through their current marketing methods. 96% of surveyed second level students are interested in virtual reality tours of college campus' and 100% of surveyed international students currently studying in DCU believe virtual reality tours will aid colleges in marketing internationally.

Open Eyes VR is a virtual reality app which allows end users to experience a virtual tour of a college campus. Through the use of 360 cameras, we record a virtual video of the college campus, which allows the end users to feel fully immersed in the campus experience and atmosphere. We will develop the virtual tour for the college which we then will make available on our app which students can download for free. Colleges will pay for the initial recording of video and audio and a yearly maintenance fee for their virtual tour on our app. Our app enables colleges to broaden their target market as the virtual tour of the campus will be available at all times from any location through our app, this allows international students to experience the college campus before they enroll. The app also allows colleges to target national students who are unable to attend the open day due to the cost of travel. Virtual tours allow the college to showcase their campus and facilities away from the college grounds at student fairs or events.

Open Eyes VR is an innovative and modern marketing technique which enables colleges to stand out from their competitors and entice more students to enroll as well as demonstrating that the college is adapting with the changes in technology

Virtual Reality is up and coming as a form of marketing, the worldwide market size is forecasted to grow by $182.2 billion from 2018 to 2022. The Irish market has a low number of competitors and no Irish college is currently using virtual reality tours as a form of marketing. Our only current competitors are American colleges however, we aim to offer a more immersive experience unlike our competitors with the majority being still click through 360 images.

2.Organisation

Organisational Structure:

Management

Open Eyes VR is a joint business venture, the two creators have very different skill sets and are both equally invested in the company. It made sense for us to separate the management under two roles. Aoibhin who is COO and main roles will be managing the commercial components of the business and Sean who is the CTO and will look after the technical components of the business. The day to day jobs when not filming will vary however, we will both be in charge of the recording and planning of the tours.

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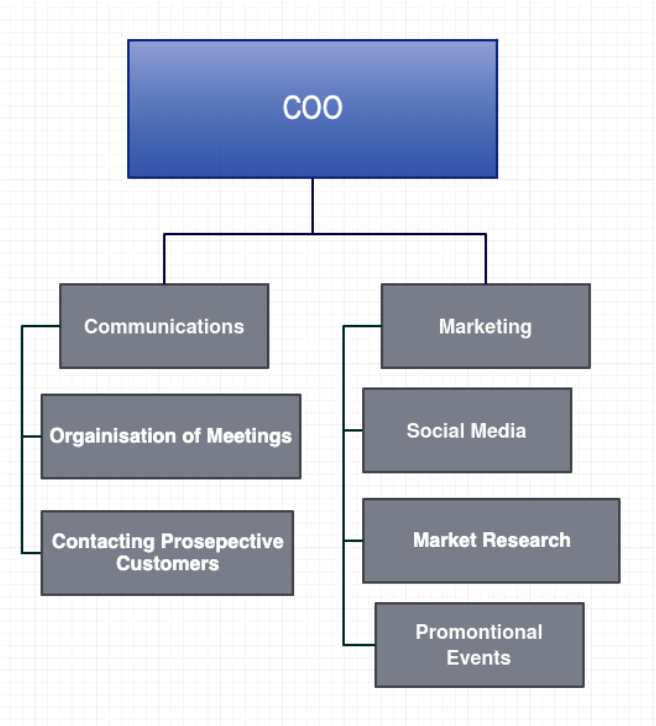
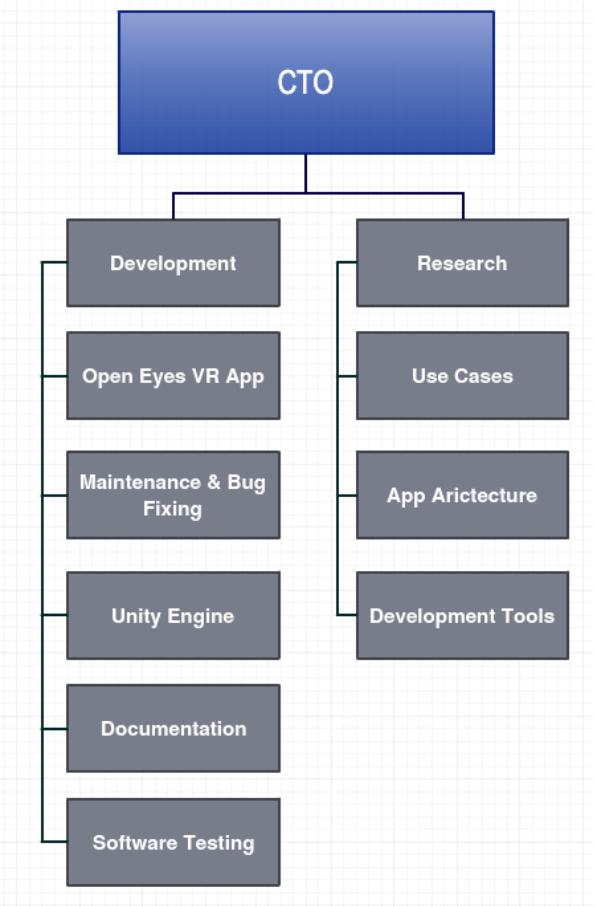
The main roles of the COO will be :

- ➢ Contacting and running the communication between us and our customers
- ➢ Plan and run promotional events and travelling.
- ➢ Evaluating the market and planning for the future of our product.
- ➢ Run our social media accounts and coordinate our marketing.

The main roles of the CTO will be :

- ➢ Developing the application and keep it up to date and running with updates.
- ➢ Edit the tours to work with the Unity environment
- ➢ Ensure data policies are being met and that we are compiling with the laws.
- ➢ Maintain the software, equipment and website.
- ➢ Run the testing of the software.





<u>Staffing & Operations:</u>

In year 1 in addition to the COO and CTO, we will recruit one new employee to assist with the development of the app so that we will be able to develop at a rate that will meet our demand while maintaining a high level of quality throughout our app. Our business will expand by recruiting an additional two employees in year 2 and 3. In year 2 one of these recruitments will be a director that will help with the filming and running of the recording sessions. They will also be in charge of recording the audio and editing the tours. As only two people are needed onsite during the recording process this will free up either the COO or the CTO to focus on other work. We are also looking to hire a developer this year to help with the development and running of the application. This is required in year 2 as we expand into the UK market and prepare to move into the European Market in year 3. This will speed

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up development on updates and testing of the application allowing us to film more colleges while still maintaining a high level of quality in our tours, as well as ensuring that we develop to meet security and data protocols of different countries as we expand. In year 3 the additional two employees will be recruited to aid with our transition into the EU market.

Team CV's:

Aoibhin' CV[Appendices 1]: https://www.linkedin.com/in/aoibh%C3%ADn-laverty-b2591061/
Sean' CV[Appendices 2]: https://www.linkedin.com/in/sean-williams-834525140/

Blogs:

Aoibhin's Blog: https://blogs.computing.dcu.ie/wordpress/aoibhinlaverty
Sean's Blog: https://blogs.computing.dcu.ie/wordpress/seanwilliams/

Workload Distribution

We segregated our workload into two segments Technical and Commercial, within these segments we both had areas which we excelled in. Sean has more technical experience and knowledge and therefore undertook the majority of the technical components, he worked within a project team on intra continuously developing and deploying applications and this aided him with the technical aspects of our project. Aoibhin's experience is with the commercial side of the business and therefore undertook the majority of the commercial components. On intra she worked as a business analyst dealing with the company's vendors as well as working with the development team on reporting. We decided to play to our strengths within the technical and commercial segments working individually on some aspects while also collaborating on the areas that we both were well versed in. This allowed us to work more efficiently and effectively to produce a high-quality application.

Technical Components (Sean)

- Researching current technologies/tools.
- Planning the system architecture of the application and the user experience
- Developing the application in the Unity Engine
- Incorporating the videos and audio into the environment.
- Debugging during development.
- Creating and deploying the project builds
- Ensuring compatibility of the application on the devices
- Documenting the development process and recording of potential future improvements
- Creation of use cases and user personas.
- Uploading the project to GitLab and keeping it updated

Commercial Components (Aoibhin)

- Contacting organisations and colleges within our target market to set up market research meetings.
- Contacting international societies to survey international students in DCU to gain insight into what they want to see from a college.
- Contact DCU to get approval to conduct market research on the open day and preparing the survey for this.
- Contact Security and Estates for approval to film on campus.
- Developing the mockups for the fully developed version of our app.

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- Record market research meetings, focus groups and survey to analyse the results.
- Recording the Audio description to be included in the app
- Contacting the relative parties to conduct user testing.
- Pricing of branded headsets

Collaborative Components

- Analysing and identifying our target market
- Recording of the Video tours/talks
- Researching competitors
- Planning and running of the software testing sessions and monitoring the feedback that is given and how we can then incorporate the improvements to our application
- Conduct market research on prospective students of DCU at the Open Day to gain insight into what they want to see from a college.
- Preparing the value proposition and business canvas.
- Financial Projections
- Planning of the building to include with the 360 video and the days in which to record.
- Monitoring regulations that our app needs to keep in line with.
- Composing our project proposal
- Market research meetings with prospective customers
- Composition of our Mid Term Report and Ethics form
- Documentation of our business plan and processes

Timeline of Completion

Semester 1:

- 1st & 2nd October: Meeting to discuss project idea and email potential supervisors
  - (*Reference: Aoibhin's Blog Post "Project Planning"*)
- 4th October: Initial meeting with potential Supervisors to get acceptance of supervision
  - (*Reference: Aoibhin's Blog Post "Initial Meeting with a Supervisor")*
- 12th October: Created and recorded our project team on the Dashboard and forked the project repository on GitLab
  - (*Reference: Sean's Blog Post "First meeting with supervisor")*
- 16th October: Started preparing our project proposal and first bi-weekly meeting with our supervisor.
  - (Reference: Aoibhin's Blog Post "Preparing the Project Proposal")
- 18th October: First emails sent out to organizations for Market Research
  - (Reference: Aoibhin's Blog Post "Initial Contacting of Colleges, Retail outlets and Tourist destinations")
- 30th October: First draft of Project Proposal.
  - (Reference: Sean's Blog Post "First Market Research meeting")
- 31st October: Market Research Meeting DCU
  - (Reference: Aoibhin's Blog Post "Market Research Meeting with DCU")
- 5th November: Reached out again to companies in other sectors to conduct market research
  - (Reference: Aoibhin's Blog Post "Further Contact with places for Market Research")
- 13th November: Finalise Proposal
  - (Reference: Aoibhin's Blog Post "Finalise Proposal")

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- 16th November: Submitted project idea digitally to the project coordinator and began researching the Technical development
  - (Reference: Aoibhin's Blog Post "Proposal Submission")
- 16th & 17th November: Conducted Market Research at DCU Open Day
  - (Reference: Aoibhin's Blog Post "DCU Open Day Market Research")
- 19th November: Emailed a survey to international societies in DCU for market research
  - (Reference: Aoibhin's Blog Post "International Students Survey")
- 20th November: Met to prepare for the presentation of our project proposal & Obtained Google Cardboard Headsets
- 21st November: Market Research Meeting Trinity
  - (Reference: Aoibhin's Blog Post "Market Research Meeting with Trinity")
- 23rd November: Presented our idea to a panel of DCU lecturers and received feedback on our concept.
  - (Reference: Aoibhin's Blog Post "Presentation of Project Idea to DCU Panel")
- 24th November: Our Project idea was Approved
- 26th November: Meeting to discuss the beginning of our application development
  - (Reference: Sean's Blog Post "Proposal Presentation and Updates")
- 27th November: Meeting to start the Midterm Report
  - (Reference: Aoibhin's Blog Post "Mid-Term and Ethics Report")
- 29th November: Meeting with Supervisor.
  - (Reference: Sean's Blog Post "Proposal Presentation and Updates")
- 3rd -10th December: Working on our Midterm Report
  - (Reference: Aoibhin's Blog Post "Mid-Term and Ethics Report")
- 6th December: Meeting with Supervisor
  - (Reference: Aoibhin's Blog Post "Meeting with Supervisor")
- 20th December: Started working on the development of our application.
  - (Reference: Sean's Blog Post "Development over Christmas")
- 22nd December: Setup Unity Engine & researched into how it is utilised.
  - (Reference: Sean's Blog Post "Development over Christmas")
- 26th December: Order Samsung Gear 360 Camera.
  - (Reference: Sean's Blog Post "Development over Christmas")
- 10th January: Obtained the 360 camera for recording the tours
- 28th January - 1st February: Finalise & Submit Midterm Report
  - (Reference: Aoibhin's Blog Post "Mid-Term and Ethics Report")

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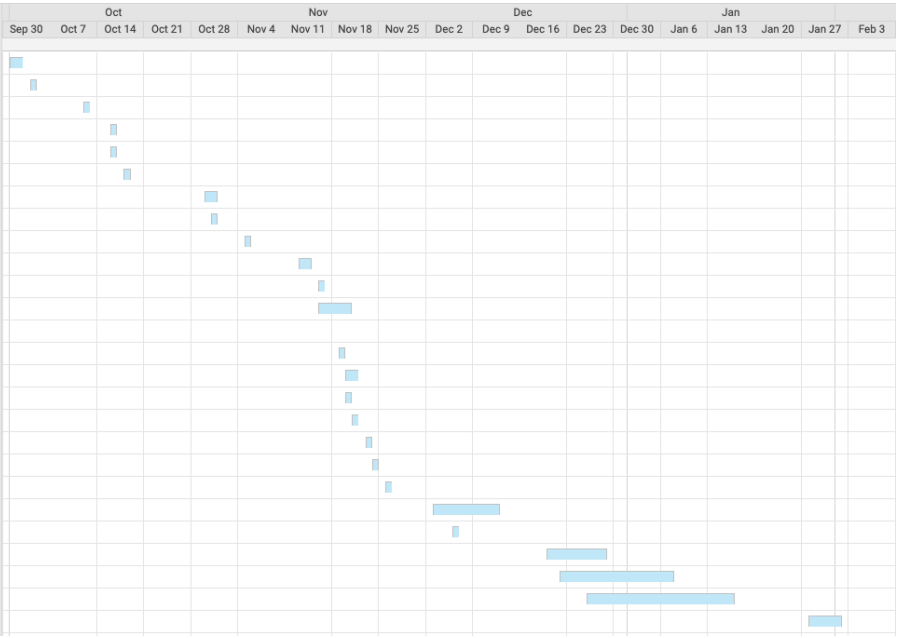
Task Name	Duration	Start
Initial Project Setup	2d	10/01/18
Initial Supervisor Meeting	0.5d	10/04/18
Project Creation	1d	10/12/18
initiating Proposal	1d	10/16/18
Supervisor Meeting	0.5d	10/16/18
Market Research	1d	10/18/18
Project Proposal Draft	2d	10/30/18
Market Research Meeting DCU	0.5d	10/31/18
Market Research	0.5d	11/05/18
Finalised Proposal	2d	11/13/18
Submit Project Idea Digitally	1d	11/16/18
Researching Technical Development	3d	11/16/18
Market Research at Open Day	2d	04/16/19
Market Research international Survey	1d	11/19/18
Presentation Preparation	2d	11/20/18
Google Cardboard Headsets	0.5d	11/20/18
Market Research Meeting Trinity	0.5d	11/21/18
Product Idea Presentation	0.5d	11/23/18
Product Idea Approval	0.5d	11/24/18
App Development Meeting	1d	11/26/18
Began Work on Midterm Report	8d	12/03/18
Meeting with Supervisor	0.5d	12/06/18
Began work on app Development	7d	12/20/18
Set up Unity Engine	12d	12/22/18
Ordered 360 Camera	16d	12/26/18
Submission of Midterm report	5d	01/28/19



Semester 2:

- 2nd February: Created environment and build setting in the Unity Engine
- 16th February: Created first build of a demo using a recording of the DCU Sign.
  - (Reference: Sean's Blog Post "First Demo Build")
- 20th February: Initial contact with DCU Estates to inform them that we would be looking to record on campus in the coming weeks & Meeting with Supervisor
  - (Reference: Aoibhin's Blog Post "Supervisor Meeting" and "Getting Permission for 360 Recording")
- 27th February: Market Research Meeting with the Chief Operations Officer in DCU
  - (Reference: Aoibhin's Blog Post "Meeting with Chief Operation Officer in DCU")
- 5th March: Meeting with Supervisor
  - (Reference: Aoibhin's Blog Post "Bi-weekly meeting with Supervisor")
- 7th March: Market Research Meeting with The Helix
  - (Reference: Aoibhin's Blog Post "Market Research Meeting with The Helix")
- 9th March: Began work on developing a menu system for our application.
  - (Reference: Sean's Blog Post "Menu System and Meetings")
- 13th March: Market Research Meeting with Residency at DCU
  - (Reference: Aoibhin's Blog Post "Market Research Meeting with DCU Residency")
- 20th March: Scheduling Recording for 360 tour of the U Building with DCU Estates
  - (Reference: Aoibhin's Blog Post "Scheduling the VR 360 Video Recording")
- 21st March: Meeting with Supervisor
  - (Reference: Aoibhin's Blog Post "Bi-weekly meeting with Supervisor")
- 26th March: Scheduling Recording for 360 tours of the Engineering and T101 building with DCU Estates & Contacting Companies to price the Branding of Virtual Headsets.
  - (Reference: Aoibhin's Blog Post "Scheduling Recording of VR 360 tour of the Engineering Building" and "Pricing of Branding Virtual Reality Headsets")

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- 27th March: Recording 360 tour of The U Building
  - (Reference: Aoibhin's Blog Post "Recording the 360 Video tour of The U Building")
- 28th March: Created demo using data gathered from the U Building and incorporating the menu options.
  - (Reference: Sean's Blog Post "Filming the tours and creating a full prototype")
- 29th March: Creating Mockups of our Application & Began working on our Final Report
  - (Reference: Aoibhin's Blog Post "Creating App Mockups")
- 2nd April: Recording 360 tour of The Stokes Building and T101
  - (Reference: Aoibhin's Blog Post "Recording 360 Virtual Tour of the Stokes Building and T101")
- 3rd April: Implemented the data gathered from the Stokes Building and T101 into our app demo & Meeting with Supervisor
  - (Reference: Aoibhin's Blog Post "Bi-weekly Meeting with Supervisor")
- 9th April: Initial Audio Description Recording
  - (Reference: Aoibhin's Blog Post "Audio Recording")
- 10th April: Incorporation of the audio description into our app.
  - (Reference: Sean's Blog Post "Recording of lecture and Audio function")
- 13th April: Conducted end-user testing at DCU Spring Open Day
  - (Reference: Aoibhin's Blog Post "End User Testing at the DCU Spring Open Day")
- 15th April: Additional Audio Description Recording
  - (Reference: Aoibhin's Blog Post "Audio Recording")
- 16th April: Additional audio description implemented on the app.
  - (Reference: Sean's Blog Post "Recording of lecture and Audio function")
- 17th April: Recording of Virtual Talk with Lecturer
  - (Reference: Aoibhin's Blog Post "Recording of virtual Talk")
- 18th of April: Full working prototype developed.
  - (Reference: Sean's Blog Post "Recording of lecture and Audio function")
- 19th April: Meeting with Supervisor to demo our finalised prototype
  - (Reference: Aoibhin's Blog Post "Bi-weekly Meeting with Supervisor")
- 23rd April: Meeting with Marketing Team and the International office in DCU to conduct end user testing
  - (Reference: Aoibhin's Blog Post "Demoing Our App For Prospective Customers")
- 20th May: Submission of final report physically and digitally
- 23rd May: Present Project at the Expedition
- 27th-30th May: Final Presentation of our developed Application

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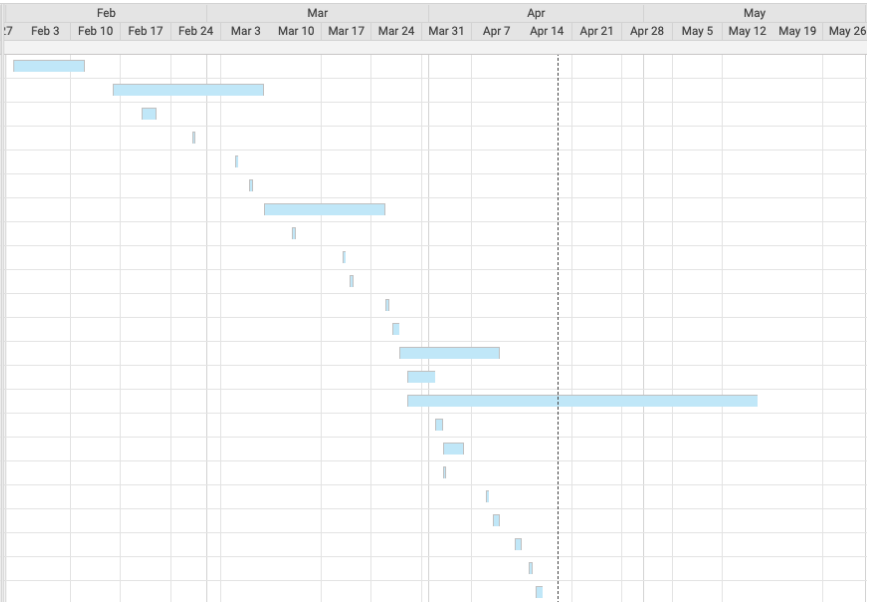
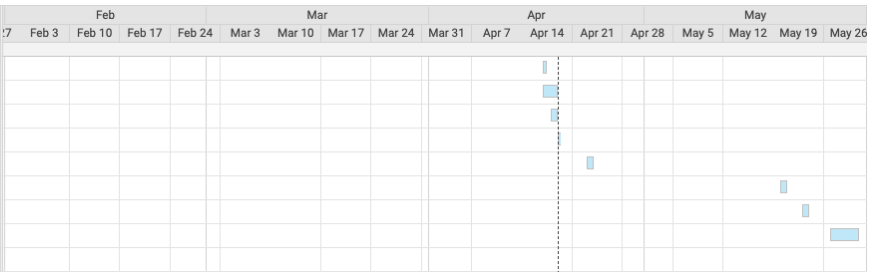
Task Name	Duration	Start
Unity Engine Setup	7d	02/02/19
First Demo Build	16d	02/16/19
Recording Permission	2d	02/20/19
Meeting with DCU COO	0.5d	02/27/19
Meeting with Supervisor	0.5d	03/05/19
Meeting with The Helix	0.5d	03/07/19
Development of App Menu	12d	03/09/19
Meeting with Residency	0.5d	03/13/19
Scheduling Video Recording	0.5d	03/20/19
Meeting with Supervisor	0.5d	03/21/19
Scheduling Second Video Recording	0.5d	03/26/19
Recording of the U Building	1d	03/27/19
Demo Using U Building & Menu	10d	03/28/19
Creating Mock Ups Of App	2d	03/29/19
Working on Final Report	35d	03/29/19
Recording of Stokes & T101	1d	04/02/19
Implemented second Recording	3d	04/03/19
Meeting with supervisor	0.5d	04/03/19
Initial Audio Recording	0.5d	04/09/19
Incorporation of Audio	1d	04/10/19
User Testing at DCU Open Day	1d	04/13/19
Additional Audio Recorded	0.5d	04/15/19
Implementation of additional audio	1d	04/16/19



Task Name	Duration	Start
Recorded Virtual Talk	0.5d	04/17/19
Implemented talk	2d	04/17/19
Fully Working prototype Developed	1d	04/18/19
Meeting with Supervisor	0.5d	04/19/19
User Testing	1d	04/23/19
Submission of Final Report	1d	05/20/19
Project Expo	1d	05/23/19
Final Presentations	4d	05/27/19



3.Business Case

Concept

Open Eyes VR is an application for virtual reality tours of college campus'. The concept of our product is to broaden the market in which colleges are able to reach while maximizing the promotion of the college and its facilities through an innovative marketing technique. Currently, colleges struggle to promote themselves internationally and outside of their region nationally. The concept of our idea is influenced by the growing rate of interest in virtual reality as well as the rate of growth of students attending third level institutes which are growing at 3% on average each year as well as the rise in the number of international students coming to Ireland to study.

Our main customer segment are colleges who will contract us out to record the 360 videos and the accompanying audio for the virtual tours, the colleges will then purchase the software from us and this will allow students to download our app for free. Once students have downloaded the app they will be able to view the virtual reality tour by placing the phone with the app opened into a virtual reality headset and they will be transported to the college campus from their current location. Our app will allow students to feel fully immersed in the college campus and get a feel for the atmosphere on campus as well as get information throughout the tour. The prototype of our product will be of Dublin City University Glasnevin Campus where we will produce virtual reality tours of two building on the campus the U building which is the new student union building on campus,the newly built Stokes

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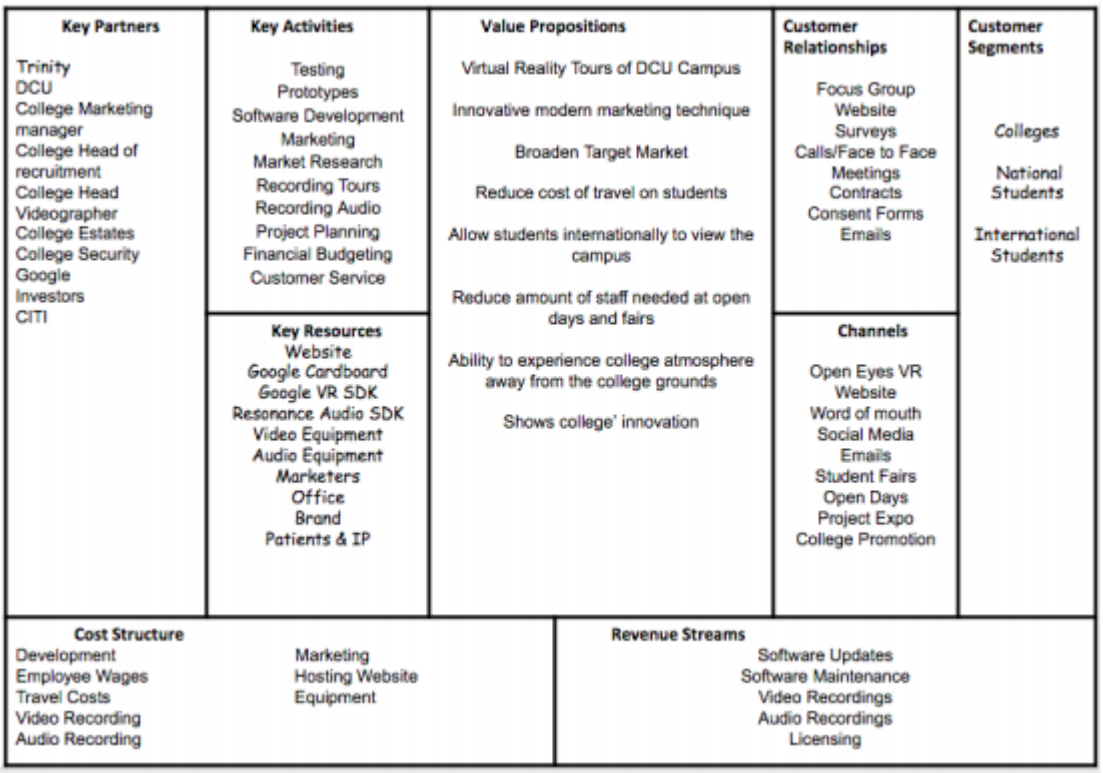
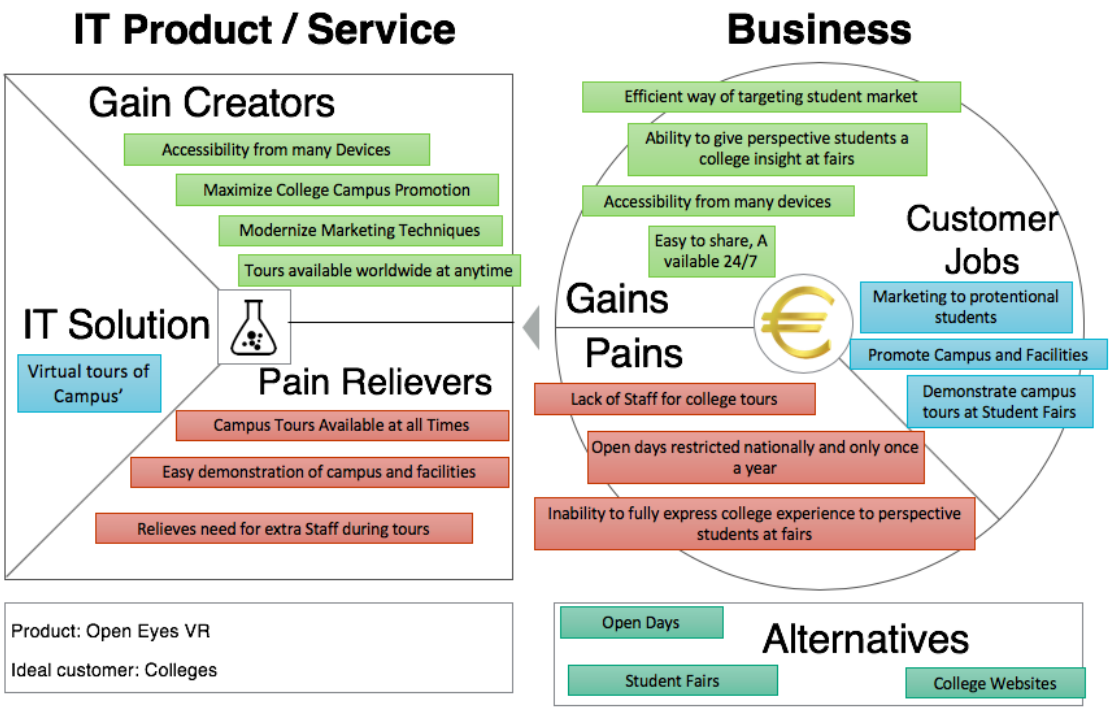
building which caters for the Engineering facility and the Glasnevin campus' largest lecture theatre T101.

Our Business Model:



Value Proposition



Open Eyes VR offers many benefits to our customers. We have two customer segments for our product, our main segment are the colleges who will purchase the software from us and

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also the end users of the product. It is important for us to keep both of these customers in mind and ensure our app is beneficial to both so that colleges would want to buy it and students want to use it.

The main benefits for the colleges are:

- ➢ Ability to give prospective students an insight into the college campus and atmosphere when promoting the college at student fairs.
- ➢ Lasting and memorable impression on prospective students as it is a modern innovative way at marketing.
- ➢ Easy to share and available 24/7 on all devices, this allows students internationally to have access to a campus tour and doesn't limit them on the device they can use to view it.
- ➢ An effective way to market to students internationally who can't attend open days and also national students who can't afford the cost of travelling to open days.
- ➢ Reduces the number of staff needed to conduct campus tours as the students are able to take a tour themselves.

The main benefits for the end user are:

- ➢ Reduce the financial burden on national students travelling to open days in other counties.
- ➢ Available on all devices and 24/7 from anywhere in the world
- ➢ International students have the opportunity to view the campus and facilities before coming over to Ireland to study.
- ➢ Aids the decision process for students as they can view the tour as many times as they wish, enabling them to make the decision on which college would suit them best.

Value Analysis

Open Eyes VR is aimed at colleges or any third level institution to aid them in increasing their marketing potential both nationally and internationally. Currently, colleges are restricted in their marketing scope to prospective students, this can be due to students being unable to travel to open days to view the college, lack of diversity in their marketing strategies or students living internationally. Through the use of our app, we aim to enable them to bridge this gap in their marketing techniques allowing them to broaden their target market reaching prospective students they couldn't before. Open Eyes VR is modern and innovative capturing the attention of the younger generation who often don't listen to the radio or quickly scrolling through ads on social media which are some of the third level institutes main methods of marketing. Our app allows colleges to demonstrate their campus and college atmosphere away from the college grounds at students fairs, this enables the college to stand out from their competitors while also drawing more students in through its unique appeal. In return, Open Eyes VR will enable colleges to increase their the impact of their marketing technique thus the number of students enrolling each year to the college will rise.

Benefits	**Client Gains**
Increase In Number of Students	➢ Colleges have the ability to broaden their target market nationally and internationally. This will increase the number of students interested in attending the college and in return,

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attending	increase the number of students enrolling. ➢ Nationally: Colleges are now able to reach students outside of their region that they could not target before due to distance and students being unable to afford high travel cost to several colleges outside of their region. ➢ Internationally: Previously Colleges struggled to find a platform that allows international students to experience their college campus and atmosphere before they enrolled. The number of international students is rapidly growing and our app allows colleges to showcase their college to this market segment. ➢ Market more effectively to students they couldn't reach before, increasing the chances of these students attending the college.
Ability to Market Internationally	➢ Demonstrate their campus to international students. ➢ Experience the college campus, facilities, resources and atmosphere before they enroll. ➢ Fully promote the college in a new innovative way that they couldn't fully get across before. ➢ Our app allows international students to envision themselves attending the college as they walk through the college campus receiving information on the buildings, course and the college overall.
Competitive Advantage	➢ Allows colleges that are utilising it as a marketing method to stand out from other colleges who have yet to use virtual tours. ➢ Demonstrate to potential students that they are innovative and keeping up with modern techniques, this can be appealing to many students to know the college they may be attending are looking to the future. ➢ Keeping up with current technologies allows colleges to be ones step ahead of their competitors making them more flexible and adaptable to change. ➢ Adapting to the rise in the number of international students coming to stud and allows them to easily market for this change in the market.
Improve Customer Service	➢ Tours are available 24/7 from all over the world from downloading the app, this allows students to be able to view the campus outside of opening hours so they are not restricted on times and days. ➢ Allows students to get information on building and courses within each building easily and quickly without having to email the college and wait on a response. ➢ Allows students outside of the country to view and experience the college campus in a way that they were not able to before. ➢ Users are guaranteed a high-quality tour.
Increase Reputation	➢ The college will be known for using a modern innovative marketing technique that not all competitors are using. ➢ Colleges offer a consistently high level of quality tour. ➢ Improve stance in the international market, become known in the

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	international market for offering a method that allows students to fully experience the college. ➢ Leave a lasting impression on students at fairs, colleges will be remembered for using a marketing method that enables them to stand out from competitors. ➢ Allows colleges to showcase their college to its full potential enabling students to envision themselves attending the college.
Reduce Number of Staff/ Volunteers needed at Open Days	➢ Colleges don't need as many volunteers to give tours of the campus at open days, this reduces costs on the college in relation to paying volunteers. ➢ Consistent and high-quality tour of the college campus as some volunteers may not know all building to a high level.
Ability to showcase their College at Student Fairs	➢ Allows colleges to showcase their college away from the campus enabling students who might not be able to attend the open day to experience the campus atmosphere and facilities. ➢ Allows students to feel fully immersed in the college campus and envision themselves attending the college as they walk through the campus. ➢ Leave a lasting impression on students at the fairs, students will leave the fair remembering the college. ➢ Students will bring their friends over to the college stand to try the virtual tour, this can allow the college to showcase their college to students who may not have been of attending the college.
Easy to Share	➢ Open Eyes VR app is available from all devices which does not restrict the college on potential students that can download the app to take their virtual tour. ➢ The app is available for students to download for free. ➢ The virtual tour is available to use as often as users want and are therefore not restricted to Open days or Student fairs. ➢ Allows colleges to redirect students who contact them outside of open days for tours of the campus to our app so that they are able to experience a campus tour to the same level as if they were at the open day. ➢ Colleges don't have to find staff that are available to facilitate a college tour outside of open days

4.Market Analysis

Target Market

In Ireland currently, there are 85 Higher Education establishments including universities, colleges and institutes enrolling 235,644 undergraduate students as of the start of 2018. These numbers will grow from the 374 secondary schools around Ireland with 194,879 students with the potential of enrolling into colleges, the number of undergrads in Ireland in the coming years will also grow immensely with the number of international students coming over to study.

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This market segment is continuously growing at a steady pace in the past few years. On average in the last for years the number of undergraduates has increased by 3% each year based on the data collected by the Higher Education Authority in their 2016/17 report. In 2016/17 the number of full-time undergraduates attending Irish colleges and universities had increased by 10% since 2013.

Our product helps colleges to forge the gap in marketing to international students. Currently, the number of international students coming over to Ireland to study is growing steadily each year. However they are only able to view prospective colleges through either college social media accounts, college websites or google search, none of these forums allows the student to picture themselves on the campus attending that college or allow them to get a full view of the campus and its facilities while being immersed in the atmosphere of the college. This can be said also for national students who live outside the region of where the college is situated, it can be expensive for them to travel to open days and college fairs as well as trying to fit it around study. Our app is unique as it closes both these gaps for the college in marketing to prospective students as well as making their marketing techniques modern and memorable to allow them to stand out from other colleges.
Our product allows colleges to broaden their marketing scope to prospective students outside of Ireland, the advantage of this is that it brings cultural diversity to the college. Colleges can also demonstrate their campus facilities, resources and atmosphere away from the college grounds in a new modern marketing technique, the advantage of this is that the virtual tours leave a lasting impression on students at fairs as it is not something they have seen before.Virtual Reality tours are a new innovative marketing technique for colleges, the advantage of this is that it shows students the college is moving with the times and advances in technology.

A hindrance we could face is that currently, not all students have access to a virtual reality headset to be able to view the tour, however from our market research 83% of students believe virtual reality will be commonplace in the next 5 years. Therefore although for now, this is a disadvantage of our product we believe it won't be in the near future. Our product involves students willingly downloading our app to view the college tour, an obstacle we may face will be convincing students to download our app. Our app is free for students to download but this doesn't guarantee they will.
Open Eyes VR is based around the future of technology therefore, we believe our app has the ability to grow in the future. We plan to expand our app outside of Ireland to colleges around the world to aid them in marketing internationally. Our product also has the ability to scale into other sectors such as retail, real estate and tourism. This will give the user the opportunity to take virtual reality tours of shops, museums, properties and well-known landmarks.

Market Research

We conducted market research into our perspective customer segments, colleges, potential end users of our app and other sectors our app could scale into.
We had a market research meeting with the head of marketing, head of recruitment and head videographer at Dublin City University. They were extremely interested in our product as a new marketing tool for DCU especially for attracting international students. They stated

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it would add to their reputation of being an innovative college showing students that they are keeping up with the changes in technology.

We also had a market research meeting with the head of marketing at Trinity College. She again echoed DCU on being extremely interested in our product as a new marketing technique for attracting international students as well of students outside of Leinster. She also said that this technique would leave a lasting impression on students especially at student fairs at it wouldn't be something every college would have and would allow them to stand out from competitors. We asked what techniques Trinity are currently using to market to students, apart from the generic Facebook, Twitter, Instagram and college website they had no way of standing out from the crowd which is what our product offers colleges.

We conducted two separate surveys, on students at the open day in DCU and on current international students in DCU to get an understanding of what they want to get from a campus tour of a prospective college.
The survey on the students at the open day showed 96% were interested in a virtual reality tour of a college campus which shows us that there is a market for our product.[Appendices 3] As we know that currently virtual reality headsets are not commonly owned we wanted to see if current students think they would become commonplace in the next few years. We found the 83% believed VR headsets would be commonplace in the next few years and that on average students would be willing to pay €20 for a virtual headset which is higher than the price of a google cardboard headset valued at €10. [Appendices 5]. We also wanted to know the main reason students attend open days so that we would be able to include those aspects into our tours to allow the user to get as much as possible out of our product, 75.95% come to open day to get information on the courses.[Appendices 4]. Taking this high percentage of students that come to open days for information on the college and courses we have decided to include audio description throughout the virtual experience to allow them to gain the same information they would if they were to attend the open day.
Survey Results: [Reference 3]

We conducted a survey on current international students attending DCU, we sent a link to the survey out to the international societies in DCU to explain our product and ask for their participation in our market research. The societies then forwarded it onto their members for us, we received a total of 12 responses from the international students. We were interested in finding out if international students would be interested in virtual reality tours of colleges with 91% saying that they would be and 100% believing that Virtual reality tours would help colleges in marketing internationally.[Appendices 7&8] Similar to the survey conducted on students attending the open day we want to see what international students would want from the tour of the college campus. We found that they were more interested in viewing the campus and its facilities. We also found that 75% would in interested in getting information on courses within the college which will be incorporated in our app through the audio description throughout the tours.[Appendices 6]
Survey Results: [Reference 4]

We met with the Chief Operations Officer in DCU to discuss our app from a budgeting standpoint for a prospective customer. We wanted to identify how much of their budget a

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college would be able to allocate to such a project and what they would expect to gain from using our app. The COO was really interested in what our app could bring to the college from a marketing standpoint, he advised us that colleges would be mainly interested in recording the main building and attractions of the college as the tour may start to feel repetitive if it showed every building and room with little variance between them. Our plan to incorporate audio description and VR talks and tutorials was a huge selling point to him as he believed it would give the end users that authentic feel of getting a guided tour as they would on an open day. In relation to a colleges budget for this, he couldn't give us exact figures but advised us that the college would look at the potential return on investment from the use of the app and weigh that up against initial cost, maintenance and updating costs. However, he believed that our app had a great potential to boost the college marketing perspective to students they currently struggle to reach both nationally and internationally which would in return raise the number of students enrolling in the college and thus increase their revenue. The competitive advantage our app gives the college was another selling point he felt would be a great incentive for colleges to use as a marketing method.
Open Eyes VR has the potential to scale into other sectors such as tourism, real estate or retail, taking this into account we conducted market research on two companies within these sectors.

As recommended by the COO we reached out to two external companies which operate within DCU, The Helix and Residency. We met with the head of marketing for the Helix, their main customers would be organisations who wish to hold an event or production in the Helix. The head of marketing was extremely interested in the use of our app to market the venue, she mentioned how some companies would send someone over to view the venue before booking it while others can't afford to do this and through the use of our app she could ridge this gap and stand out from competitors. She also discussed with us how branded headsets would be an ideal gift to send to previous or potential customers to showcase The Helix.

We also meet with the business development management within residency at DCU, residency rent the accommodation to students during the college term and to tourists over the summer. Our app would allow them to showcase their available accommodation in a more innovative way to allow prospective customers to get a greater sense of where they will be staying. He was really impressed with our idea and saw great potential for it within this market space, he also informed us that he was currently looking into virtual reality tours of the conference rooms with DCU and had recently reached out to the company Headbox about this. Although they are currently using this company for the conference rooms across DCU campus' they had not looked into using it for the purpose of accommodation, this company also only offered still click through image which would not deliver the same immersive feeling we believe we can give our end user through the use of 360 videos. This meeting offered us a great insight into the competition out there and to also what prospective customers are looking for.

Total Market Valuation

The global market for virtual reality is set to grow rapidly by 2022. Virtual reality is the next step in allowing consumers to become fully immersed in the experience, as well as benefiting training and learning by stimulating situations. The market for virtual reality is

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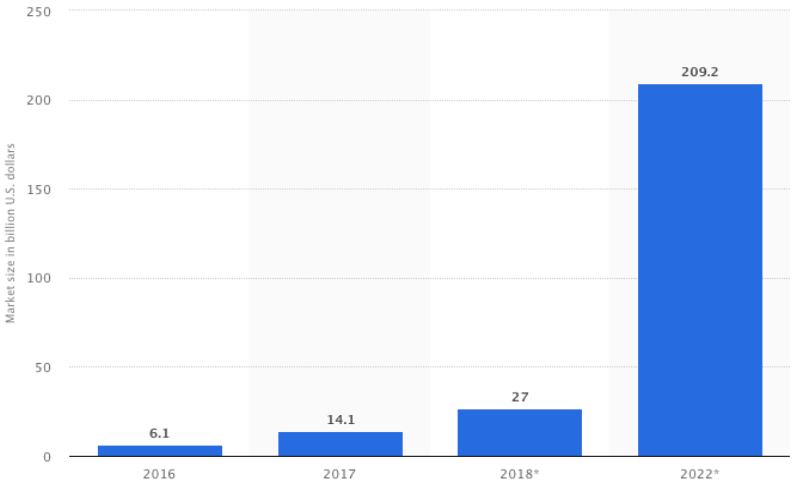
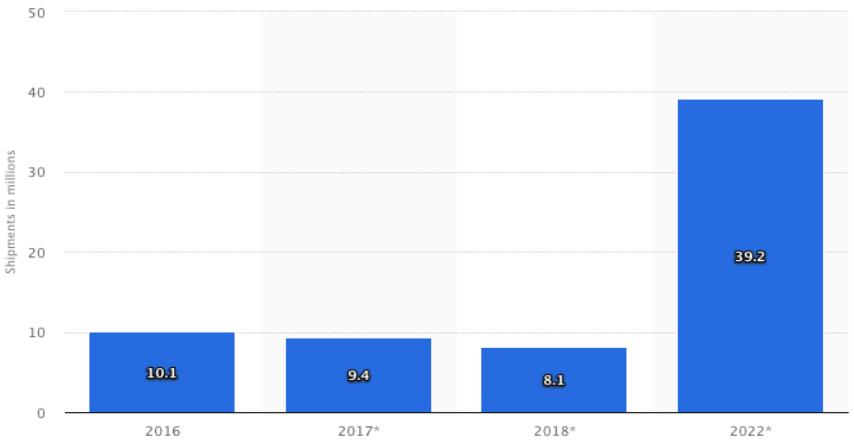
forecasted to grow up to $182.2 billion from 2018 to 2022 and the sale of VR headsets is forecasted to rise to $31.1 billion from 2018 to 2022.

Based on the forecasted growth of both the market size and sales of VR headsets our product comes into the market at the being of this growth, taking advantage of the potential market before other competitors. Entering this market early on we will enable us to stay ahead of competitors by easily adapting to new technologies coming into the market for virtual reality.

Forecasted Market Size WorldWide of Virtual Reality from 2016 to 2022





Forecasted Shipment of VR Headset from 2016 to 2022

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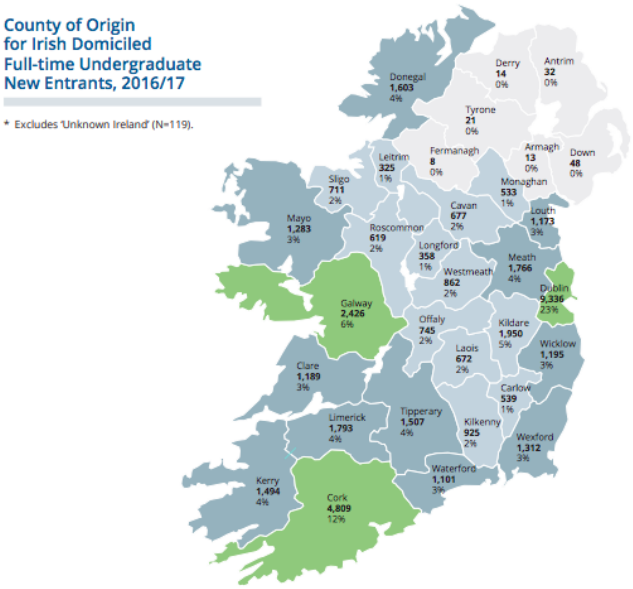
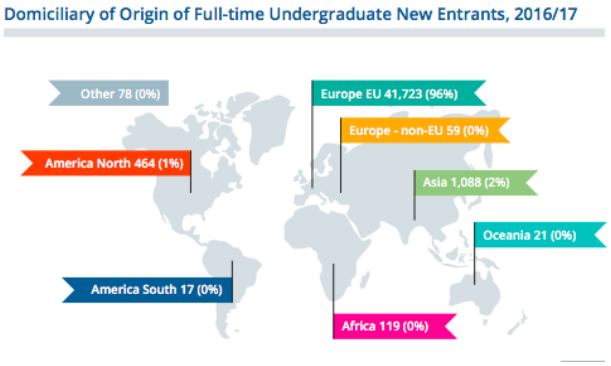
Market Trends





Our target market will be third level institutions and the source market is third level institutes and second level institutes.This market has been growing steadily over the past few years with 85 higher education establishment having 235,644 enrolled as of the start of 2018, these establishments will are set to grow in the coming years with 194,879 students attending 374 secondary schools nationwide with the potential to enroll in third level education. In 2016/17 universities and colleges in Ireland had 225,628 full-time undergraduates enrolled, this number has increased by 10% in the last five years. These numbers are based on the Higher Education Authority Report for 2016/17.

The potential for our target market is on average a 3% growth in the number of undergraduates attending college each year based on the rate of growth in the last four years. This is taking into account the growing number of national students attending college as while as the increasing number of international students coming over to Ireland to study.

The number of international students is set to grow rapidly post-Brexit as Ireland will be one of the few only English speaking countries within the EU. Ireland is the chosen destination by students internationally to further their education due to its reputation for high-quality education, the Irish education system is one of the best in Europe.

With new GDPR regulations in affect colleges and universities are being held more responsible for the data they keep on their students they must be able to justify why such data is kept. GDPR also introduced a new requirement in information handling and storing, under GDPR colleges and universities are restricted in direct marketing therefore, our product gives them an alternative way to market to potential students.

Based on these current trends within our target market our product has the potential to aid colleges in marketing for the increasing numbers in students enrolling. Open Eyes VR can bridge the gap in international marketing techniques, it allows students from all over the world to experience the college atmosphere and facilities before they decide which college is suited to them. This product is coming into the market at the ideal time as there is a steady rise in the number of international students coming to Ireland to study and our product gives them the possibility to immerse themselves in the college campus and envision themselves studying at that college. GDPR will have a slight impact on our recording of the tours as we need to ensure consent from any party captured, however this is easily resolved with the use of facial blurring or consent form around the site while filming as well as 24 hour notice given on the campus to students before the recording will take place.

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In keeping with the current trends in this market, the rise in the number of students both nationally and internationally attending college will grow steadily in the coming years. Taking these statistics into consideration Open Eyes VR will grow nationally in Ireland in the first two years enabling the product reputation to grow, the app will then expand into the international markets covering Europe firstly due to similar regulations and process. As the market grows our product will grow with it, education is a vital part of life today and therefore giving all students the best opportunity to select a college best suited to them is what we aim to provide.

Competitors

Currently, we could find no other colleges in Ireland that are utilising virtual reality tours of their campus as a marketing technique. In America there are colleges currently using virtual tours of the campus as a form of marketing, however, the majority of the tours are usually embedded into the websites and therefore harder for students to envision themselves on the campus.

Our main competitors:

- University of North Carolina: The University of North Carolina is currently in the process of developing a virtual tour of their college campus. This app is currently in early development stages and still undergoing testing. It was designed as students found that the guided tours they received at the open days of the university did not meet their requirements, from the early testing they have already done students are liking the virtual reality tours better as they get a feel for the what a normal day in the college is like rather than being told by a tour guide.

- Headbox: A transactional marketplace for events, meetings and offsite spaces which offer the option of hosting a virtual reality click through tour of your venue using still images and embedded on their website. The offer virtual tours a range of restaurant, attractions and meeting rooms to allow the user to view potential venues in a 360 environment before they book it. While researching this company it seemed that their main focus was on having a site which could be a one-stop place for end users looking for a venue and that the 360 tour was an optional aspect to this.

- YouVisit: Virtual campus tours for a variety of American colleges, offer the option to view a 360 experience on your desktop or to convert your screen into a virtual environment compatible with OCULUS RIFT. Both versions of the virtual tour offered are embedded in the website and not available as a downloadable app. In the 360 experience, they use still images where the user doesn't have the freedom to move around as they wise and have to click the arrows shown. They do however offer an audio description of the areas you are viewing on the campus. We were unable to test out their 360 tours that are offered through the use of OCULUS RIFT as we did not have access to this headset.

Competitive Advantage

Open Eyes VR stands out from its competitors as we provide our end users with a virtual experience that allows them to feel fully immersed in the college campus and its atmosphere. We do this through:

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- Offering the option of audio description as the user takes the virtual tour, this aspect allows the user to receive the information on the building and facilities on the college campus that they would on an open day. We identified the inclusion of audio as a vital feature based on our market research we found a high majority of potential students at 79% come to open days for information on the college.
- Our product is available in the form of a downloadable app, this allows end users to be able to access the virtual tour easily no matter where they are. In comparison to the majority of our current competitors who offer their 360 experience embedded on a website which is not as accessible and also doesn't off the same immersive feeling of being on the college campus as an app viewed through a Virtual headset would.
- Our app is developed using 360 video recording rather than still images used by our competitors. We choose to use videos as it allows the user to get more of a feel for the atmosphere on the college campus. As seen in some of our competitor's virtual environment the 360 images often restrict the user on what they can see i.e. a tour on the VisitYou website would not let you click to see an area of the image or allow the arrow in front to move onto a new location. We felt this didn't offer the users the same realistic tour that a 360 video would.
- Open Eyes VR allows end users to view Virtual Talks from lecturers or guest speakers of the college. These talks are similar to the talks available at the open day that would give students an insight into the course they want to study. This is another aspect of our app that enables us to stand out from the competition in our market.

Challenges in Bringing to Market

Some potential challenges we have identified in bringing our app to market are staying ahead of our competitors in offering virtual tours to potential customers before our competitors, ensuring our app and the technology we used to develop our app is adaptable to potential changes in technology in the future so that it does not become outdated and unusable for our customers. We are also aware that currently, virtual reality is only in its infancy as a marketing technique and some potential customers may be hesitant to adopt it as a marketing technique as well as not all prospective end user will have access to a VR headset. However, we have conducted market analysis within these customer segments that have verified for us that these customer segments would have a huge interest in virtual reality and believe it will be more common in the next 5 years.
Although there are some obstacles we may need to overcome in bringing our app to market, we feel we have researched the market segment, competitors and prospective customers and end users to the extent that our app will be able to overcome these challenges and prove to be a successful marketing technique for many colleges.

5. Financial Projections

Revenue

Our main source of income each year will be from the recording of the 360 virtual videos, this can be seen in our Profit and Loss Accounts depicted below where each year it accounts for over 70% of our total income. The cost for the video recording is accumulated from the cost of the recording which we have charged at €1000 per minute with the average

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campus tour lasting on average 3 minutes. This is then multiplied by the average number of buildings on the campus we will record and the number of colleges we projected to record that year. In our first year we aim to record virtual tours for 13 colleges in Ireland, we then aim to record for 27 colleges in year 2 with 18 of these being in the UK market and finally in year 3 we aspire to record virtual tours for 50 colleges within the EU and UK market. The next main source of income for our company will be from the additional features the prospective customers can opt to purchase to ensure they stand out even more from their competitors. These additional features fall under the other category of our profit and Loss Account and are accumulated from the cost of the branded headsets per unit at €2.00 to our customers with on average around half our customers opting to purchase these to further their competitive advantage at a standard rate of 5,000 units. Our other sources of income are from the updating and maintaining of the software on our app. Updates are associated with the cost of included virtual talks from lectures or speakers in the college we averaged this at 2 talks per college at a rate of €500 per talk. Maintenance is the yearly fee in which our customers pay to ensure their tours place on our app. Our income is broken down into our projected monthly rate for each year in our CashFlow projections below.

One of our company's main expense each year is on employee salaries with the next major expenditure for external cost which is an accumulation of the cost for our company to obtain the branded headset off an external business and the cost associated with publishing our app on the major app stores. On average the cost of us obtaining the branded headset is €1.60 per unit with a €500 delivery charge, based on this we charge our customers a rate of €2.00 per headset to cover some of this expense. In order for our ability to be available on the major app store we must pay a publishing fee, for Android this is a once off payment of €25.00 and for Apple, it is a yearly fee of €100.00.

Due to the nature of our product travel is a major expense for our company as we need to be onsite to record the campus' for the virtual tour as well as meeting with the colleges to discuss what they want to be included in their tour. We divided our travel into various sections, cost of travel for onsite recording, cost of travel for meetings with the colleges, cost of travel to student fairs and in year 2 and 3 we will have international travel costs. On average we predicted that for travelling for onsite recordings and meeting with the colleges in Ireland would be around €100.00 per employee each trip with two employees needed per trip. This cost is then multiplied by the number of Irish colleges we would be recording for that year as well as the number of trips needed, we estimated 3 trips were needed for recording and 2 trips needed for meetings per college.
In year 2 and 3 with the expansion of our product into international markets, we need to take these higher costs of travelling into account. We projected an averaging cost of €125.00 per person each way on flights and €50 on accommodation per person per night, with two employees per trip and 4 days needed for each trip. The trips were needed only for the days we would be recording on-site as we plan to conduct our main meetings with the international colleges via Skype. The number of trips needed was based on our estimated number of international colleges that we would be recording a virtual tour for.
In order to promote our app to potential customers and end users, we plan to be in attendance at the major student fairs to demonstrate our app o both parties. In year 1 we will be attending 2 fairs in Ireland as this is our primary market this year. Our estimated

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expenditure is based off the average price to travel to the fair being €30 year as the major student fairs are based in Dublin and usually last 2 days and would need the attendance of 2 employees. In year 2 and 3, as we are expanding our company outside of Ireland, we would need to attend college fairs in those countries. In year 2 we will attend 4 fairs two in Ireland and 2 in the UK as these are our target markets for this year, in year 3 we will attend a total of 6 fairs with the additional 2 fairs on last year being 2 fairs within the European countries we are targeting. With the need of travelling abroad to attend fair in year 2 and 3 we included the cost of flights and accommodation of attending these fairs into our expenses, with the average on return flights being €150 for UK trips and €250 for trips to the EU. Accommodation is estimated at €50 per person per night again with to employees needed in attendance and the fairs lasting on average 2 days.

In relation to marketing our virtual tours app so that we will be able to expand into these markets, we plan to use social media as our main marketing technique. A reason we choose the social media platform is that the vast majority of the end users of our app have a form or social media and it is also a majorly effective method while also keeping costs to a minimum. Our main cost of social media is for the ads based service so that our product is displayed to the users, this is a monthly fee of €40.00. As well as using social media to promote our product we also have our website for user to visit which is a monthly fee of €25.00 to host in conjunction to this we plan to attend the major tech events and conference to showcase our app. We plan to attend 3 events in year 1, 4 events in year 2 and 6 events in year 3. The cost of renting a promotional stand at each of these events is around €700.00, as well as our stand we would need posters to promote our app we project for this price to vary over the years the amount we need will increase as we expand. The average price over the 3 years that we estimate to spend on posters for our product promotion is around €150.
Another cost associated with our business is the purchasing of the equipment we will need during the recording and development processes of the virtual tours. The majority of our expenditure on equipment is in year 1 as this year we will need to purchase all the equipment required for recording the 360 tours. In year 2 we will mainly be maintaining the equipment purchased in year 1 but have also allocated some finances towards equipment that may need updating or replacing, in year 3 our expenditure will go up again as we will need to purchase more equipment due to the expansion of our company into the European market. Our equipment costs are to cover the purchasing of the 360 cameras, audio equipment, travel equipment, software, server and VR headsets. We estimated to spend €3710 in year 1, €3140 in year 2 and €3940 in year 3.

As a company we plan to work out of a hot-desking office at a rate of €162 per person per month in temple bar, this suits our company as we are still growing and don't require a lot of office space with the current size of our company. The rate of €162 is inclusive of all related costs of running an office such as electricity. As a company, we want to ensure we are covered to deal with any circumstances out of our control. To cover our company we have invested in professional liability insurance so that we are protected as a service providing company, general liability insurance to ensure we are covered against any claims of injury or property damage and insurance for our equipment in the case of accidental damages. In year 2 and year 3 we will be looking into obtaining data breach insurance to cover us on complying with the laws and regulations associated with different countries as we expand.

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Our insurances expenses of based off a monthly fee that would be average for the size of our business, this fee increases each year as the number of employees and our business expands.

Taking into account income, expenses and potential growth our current projections for the company's net profit over the first three years is stated below. This is broken down further in the excel extracts in the Profit and Loss Accounts and CashFlow sections of our report as well as within our excel file on Google Drive [Reference 5].

2019	2020	2021
€76,101.00	**€184,190.00**	**€405,164.00**

Profit and Loss Accounts

INCOME		2019	% of OI	2020	% of OI	2021	% of OI
	Operating Income						
	Video Recording	€195,000.00	72.41%	€405,000.00	71.55%	€750,000.00	70.82%
	Software Updating	€13,000.00	4.83%	€27,000.00	4.77%	€50,000.00	4.72%
	Software Maintenance	€1,300.00	0.48%	€4,000.00	0.71%	€9,000.00	0.85%
	Other	€60,000.00	22.28%	€130,000.00	22.97%	€250,000.00	23.61%
	Total Operating Income (OI)	**€269,300.00**		**€566,000.00**	-	**€1,059,000.00**	-
Total INCOME		**€269,300.00**	-	**€566,000.00**	-	**€1,059,000.00**	-
EXPENSES							
	Operating Expenses						
	Payroll	€106,213.42	54.98%	€203,989.75	53.43%	€312,332.93	47.77%
	PAYE / PRSI	€4,510.08	2.33%	€8,769.60	2.30%	€13,446.72	2.06%
	USC	€2,028.50	1.05%	€6,480.65	1.70%	€10,388.35	1.59%
	Insurance	€1,680.00	0.87%	€2,940.00	0.77%	€3,420.00	0.52%
	Travel	€15,360.00	7.95%	€32,440.00	8.50%	€78,440.00	12.00%
	Equipment	€3,710.00	1.92%	€3,140.00	0.82%	€3,940.00	0.60%
	Marketing	€2,740.00	1.42%	€3,730.00	0.98%	€5,660.00	0.87%
	Rent	€5,832.00	3.02%	€9,720.00	2.55%	€13,608.00	2.08%
	Other	€51,125.00	26.46%	€110,600.00	28.97%	€212,600.00	32.52%
	Total Operating Expenses	**€193,199.00**		**€381,810.00**		**€653,836.00**	
Total EXPENSES		**€193,199.00**	-	**€381,810.00**		**€653,836.00**	
NET INCOME		**€76,101.00**		**€184,190.00**		**€405,164.00**	

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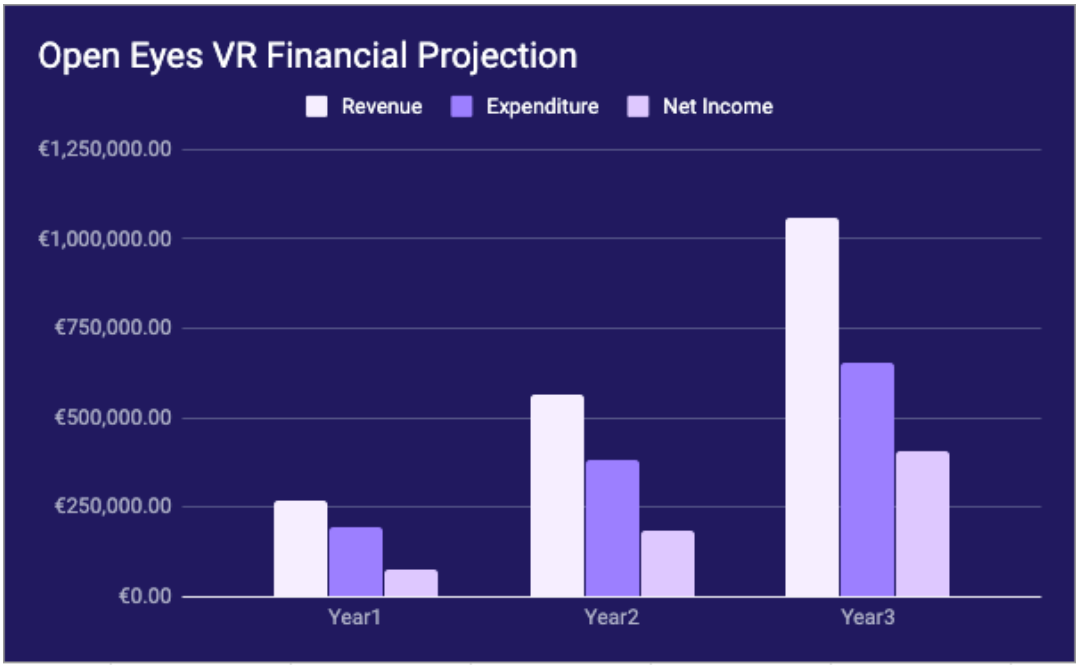

Cashflow Projections

	Cashflow Year 1											
	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
Inflows												
Video Recording	€16,250.00	€16,250.00	€16,250.00	€16,250.00	€16,250.00	€16,250.00	€16,250.00	€16,250.00	€16,250.00	€16,250.00	€16,250.00	€16,250.00
Software Updating	€1,083.33	€1,083.33	€1,083.33	€1,083.33	€1,083.33	€1,083.33	€1,083.33	€1,083.33	€1,083.33	€1,083.33	€1,083.33	€1,083.33
Software Maintenance	€108.33	€108.33	€108.33	€108.33	€108.33	€108.33	€108.33	€108.33	€108.33	€108.33	€108.33	€108.33
Additional Features	€5,000.00	€5,000.00	€5,000.00	€5,000.00	€5,000.00	€5,000.00	€5,000.00	€5,000.00	€5,000.00	€5,000.00	€5,000.00	€5,000.00
Total Inflows	**€22,441.67**	€22,441.67	€22,441.67	€22,441.67	€22,441.67	€22,441.67	€22,441.67	€22,441.67	€22,441.67	€22,441.67	€22,441.67	€22,441.67
Outflows												
Payroll	€8,851.12	€8,851.12	€8,851.12	€8,851.12	€8,851.12	€8,851.12	€8,851.12	€8,851.12	€8,851.12	€8,851.12	€8,851.12	€8,851.12
PAYE / PRSI	€375.84	€375.84	€375.84	€375.84	€375.84	€375.84	€375.84	€375.84	€375.84	€375.84	€375.84	€375.84
USC	€169.04	€169.04	€169.04	€169.04	€169.04	€169.04	€169.04	€169.04	€169.04	€169.04	€169.04	€169.04
Insurance	€140.00	€140.00	€140.00	€140.00	€140.00	€140.00	€140.00	€140.00	€140.00	€140.00	€140.00	€140.00
Travel	€1,280.00	€1,280.00	€1,280.00	€1,280.00	€1,280.00	€1,280.00	€1,280.00	€1,280.00	€1,280.00	€1,280.00	€1,280.00	€1,280.00
Equipment	€309.17	€309.17	€309.17	€309.17	€309.17	€309.17	€309.17	€309.17	€309.17	€309.17	€309.17	€309.17
External costs	€4,260.42	€4,260.42	€4,260.42	€4,260.42	€4,260.42	€4,260.42	€4,260.42	€4,260.42	€4,260.42	€4,260.42	€4,260.42	€4,260.42
Rent	€486.00	€486.00	€486.00	€486.00	€486.00	€486.00	€486.00	€486.00	€486.00	€486.00	€486.00	€486.00
Marketing	€228.33	€228.33	€228.33	€228.33	€228.33	€228.33	€228.33	€228.33	€228.33	€228.33	€228.33	€228.33
Total Outflows	**€16,099.92**	**€16,099.92**	**€16,099.92**	**€16,099.92**	**€16,099.92**	**€16,099.92**	**€16,099.92**	**€16,099.92**	**€16,099.92**	**€16,099.92**	**€16,099.92**	**€16,099.92**
Net Cash Inflow / (Outflow)	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75
Cash Reconciliation												
Previous year closing balance	€0.00											
Opening Balance	€20,000.00	€26,341.75	€32,683.50	€39,025.25	€45,367.00	€51,708.75	€58,050.50	€64,392.25	€70,734.00	€77,075.75	€83,417.50	€89,759.25
Net Cash Inflow / (Outflow)	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75	€6,341.75
Closing Balance	€26,341.75	€32,683.50	€39,025.25	€45,367.00	€51,708.75	€58,050.50	€64,392.25	€70,734.00	€77,075.75	€83,417.50	€89,759.25	€96,101.00

	Cashflow Year 2											
	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20
Inflows												
Video Recording	€33,750.00	€33,750.00	€33,750.00	€33,750.00	€33,750.00	€33,750.00	€33,750.00	€33,750.00	€33,750.00	€33,750.00	€33,750.00	€33,750.00
Software Updating	€2,250.00	€2,250.00	€2,250.00	€2,250.00	€2,250.00	€2,250.00	€2,250.00	€2,250.00	€2,250.00	€2,250.00	€2,250.00	€2,250.00
Software Maintenance	€333.33	€333.33	€333.33	€333.33	€333.33	€333.33	€333.33	€333.33	€333.33	€333.33	€333.33	€333.33
Additional Features	€10,833.33	€10,833.33	€10,833.33	€10,833.33	€10,833.33	€10,833.33	€10,833.33	€10,833.33	€10,833.33	€10,833.33	€10,833.33	€10,833.33
Total Inflows	**€47,166.67**	**€47,166.67**	**€47,166.67**	**€47,166.67**	**€47,166.67**	**€47,166.67**	**€47,166.67**	**€47,166.67**	**€47,166.67**	**€47,166.67**	**€47,166.67**	**€47,166.67**
Outflows												
Payroll	€16,999.15	€16,999.15	€16,999.15	€16,999.15	€16,999.15	€16,999.15	€16,999.15	€16,999.15	€16,999.15	€16,999.15	€16,999.15	€16,999.15
PAYE / PRSI	€730.80	€730.80	€730.80	€730.80	€730.80	€730.80	€730.80	€730.80	€730.80	€730.80	€730.80	€730.80
USC	€540.05	€540.05	€540.05	€540.05	€540.05	€540.05	€540.05	€540.05	€540.05	€540.05	€540.05	€540.05
Insurance	€245.00	€245.00	€245.00	€245.00	€245.00	€245.00	€245.00	€245.00	€245.00	€245.00	€245.00	€245.00
Travel	€2,703.33	€2,703.33	€2,703.33	€2,703.33	€2,703.33	€2,703.33	€2,703.33	€2,703.33	€2,703.33	€2,703.33	€2,703.33	€2,703.33
Equipment	€261.67	€261.67	€261.67	€261.67	€261.67	€261.67	€261.67	€261.67	€261.67	€261.67	€261.67	€261.67
Marketing	€310.83	€310.83	€310.83	€310.83	€310.83	€310.83	€310.83	€310.83	€310.83	€310.83	€310.83	€310.83
External costs	€9,216.67	€9,216.67	€9,216.67	€9,216.67	€9,216.67	€9,216.67	€9,216.67	€9,216.67	€9,216.67	€9,216.67	€9,216.67	€9,216.67
Rent	€810.00	€810.00	€810.00	€810.00	€810.00	€810.00	€810.00	€810.00	€810.00	€810.00	€810.00	€810.00
Total Outflows	**€31,817.50**	**€31,817.50**	**€31,817.50**	**€31,817.50**	**€31,817.50**	**€31,817.50**	**€31,817.50**	**€31,817.50**	**€31,817.50**	**€31,817.50**	**€31,817.50**	**€31,817.50**
Net Cash Inflow / (Outflow)	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17
Cash Reconciliation												
Opening Balance	€96,101.00	€111,450.17	€126,799.33	€142,148.50	€157,497.67	€172,846.83	€188,196.00	€203,545.17	€218,894.33	€234,243.50	€249,592.67	€264,941.83
Net Cash Inflow / (Outflow)	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17	€15,349.17
Closing Balance	€111,450.17	€126,799.33	€142,148.50	€157,497.67	€172,846.83	€188,196.00	€203,545.17	€218,894.33	€234,243.50	€249,592.67	€264,941.83	€280,291.00

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	Cashflow Year 3											
	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21
Inflows												
Video Recording	€62,500.00	€62,500.00	€62,500.00	€62,500.00	€62,500.00	€62,500.00	€62,500.00	€62,500.00	€62,500.00	€62,500.00	€62,500.00	€62,500.00
Software Updating	€4,166.67	€4,166.67	€4,166.67	€4,166.67	€4,166.67	€4,166.67	€4,166.67	€4,166.67	€4,166.67	€4,166.67	€4,166.67	€4,166.67
Software Maintenance	€750.00	€750.00	€750.00	€750.00	€750.00	€750.00	€750.00	€750.00	€750.00	€750.00	€750.00	€750.00
Additional Features	€20,833.33	€20,833.33	€20,833.33	€20,833.33	€20,833.33	€20,833.33	€20,833.33	€20,833.33	€20,833.33	€20,833.33	€20,833.33	€20,833.33
Total Inflows	**€88,250.00**	**€88,250.00**	**€88,250.00**	**€88,250.00**	**€88,250.00**	**€88,250.00**	**€88,250.00**	**€88,250.00**	**€88,250.00**	**€88,250.00**	**€88,250.00**	**€88,250.00**
Outflows												
Payroll	€26,027.74	€26,027.74	€26,027.74	€26,027.74	€26,027.74	€26,027.74	€26,027.74	€26,027.74	€26,027.74	€26,027.74	€26,027.74	€26,027.74
PAYE / PRSI	€1,120.56	€1,120.56	€1,120.56	€1,120.56	€1,120.56	€1,120.56	€1,120.56	€1,120.56	€1,120.56	€1,120.56	€1,120.56	€1,120.56
USC	€865.70	€865.70	€865.70	€865.70	€865.70	€865.70	€865.70	€865.70	€865.70	€865.70	€865.70	€865.70
Insurance	€285.00	€285.00	€285.00	€285.00	€285.00	€285.00	€285.00	€285.00	€285.00	€285.00	€285.00	€285.00
Travel	€6,536.67	€6,536.67	€6,536.67	€6,536.67	€6,536.67	€6,536.67	€6,536.67	€6,536.67	€6,536.67	€6,536.67	€6,536.67	€6,536.67
Equipment	€328.33	€328.33	€328.33	€328.33	€328.33	€328.33	€328.33	€328.33	€328.33	€328.33	€328.33	€328.33
Marketing	€471.67	€471.67	€471.67	€471.67	€471.67	€471.67	€471.67	€471.67	€471.67	€471.67	€471.67	€471.67
External costs	€17,716.67	€17,716.67	€17,716.67	€17,716.67	€17,716.67	€17,716.67	€17,716.67	€17,716.67	€17,716.67	€17,716.67	€17,716.67	€17,716.67
Rent	€1,134.00	€1,134.00	€1,134.00	€1,134.00	€1,134.00	€1,134.00	€1,134.00	€1,134.00	€1,134.00	€1,134.00	€1,134.00	€1,134.00
Total Outflows	**€54,486.33**	**€54,486.33**	**€54,486.33**	**€54,486.33**	**€54,486.33**	**€54,486.33**	**€54,486.33**	**€54,486.33**	**€54,486.33**	**€54,486.33**	**€54,486.33**	**€54,486.33**
Net Cash Inflow / (Outflow)	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67
Cash Reconciliation												
Opening Balance	€280,291.00	€314,054.67	€347,818.33	€381,582.00	€415,345.67	€449,109.33	€482,873.00	€516,636.67	€550,400.33	€584,164.00	€617,927.67	€651,691.33
Net Cash Inflow / (Outflow)	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67	€33,763.67
Closing Balance	€314,054.67	€347,818.33	€381,582.00	€415,345.67	€449,109.33	€482,873.00	€516,636.67	€550,400.33	€584,164.00	€617,927.67	€651,691.33	€685,455.00

6.Technical Specification

Software Specification

Our product will be an application for smartphones that will provide virtual tours through the use of a virtual reality headset. By moving their head with the headset on, our application will pick up on the movement and move along with the user to change the perspective of what is being shown. Our product will be an application that is downloadable for smartphones and delivers the experience of attending a college open day by giving the user a virtual tour that they are in control of. We are using the Unity engine along with the Google VR SDK to create the APK which will work on Android devices and eventually iPhones that meet the system requirements (example android OS which is greater than version 4.4). The application will be triggered by the user selecting that app on their device which will then enter into a virtual reality mode that will be used in conjunction with a google cardboard headset or similar headsets. The user will then place the smartphone into the headset and be brought to the main menu which will be controlled by Virtual Reality Gaze Tracking that tracks your centre of vision and along with the use of a button on the headset, the user will be able to navigate and control the app within its headset.

Our first version of the app will focus solely on the Dublin City University Glasnevin Campus, eventually expanding to add more colleges to our selection. We offer three separate tours on our app currently, one of the new Student Union Building, The Stokes and the lecture hall T101. The user will select one of these tours in our main menu and the tour will start on the app, this is 360 video that we have recorded of the selected building. At the bottom of the VR view, there is a menu that the user will be able to control using the gaze interaction previously mentioned. This menu will allow the user to navigate the scenes by going forward and backwards in the tour, along with a play and a pause button for the video, an audio play and pause button, a home menu button and an exit button which closes the app. By choosing the next option the next scene of the tour will be played which will be another spot in the building that we have recorded. Each tour currently has three scenes within it but will be expanded upon in a future version.

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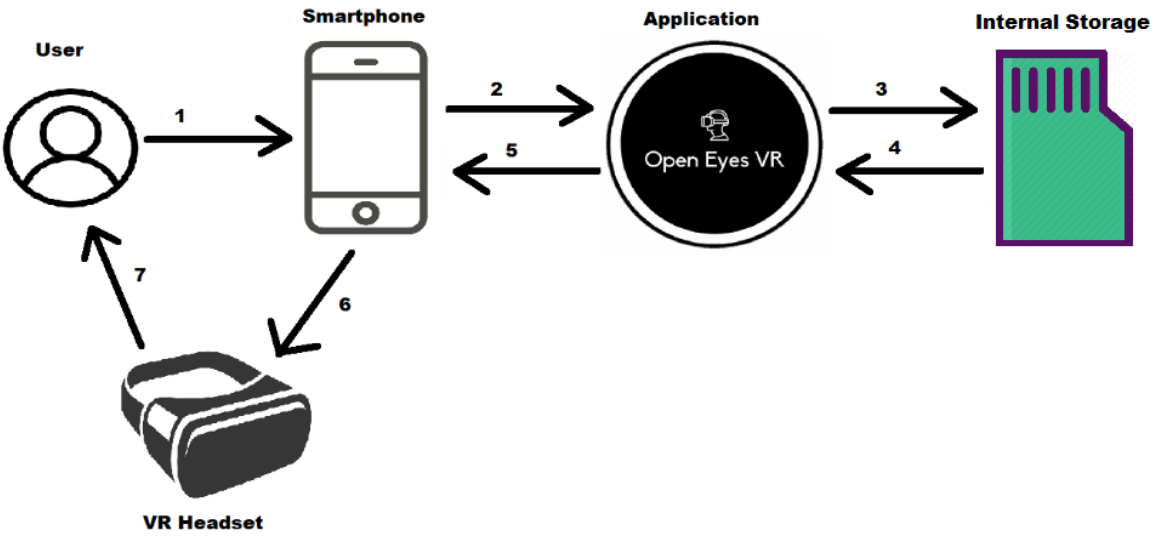
Each scene is between 20 and 30 seconds of length with testing identifying that users usually spend between 10 and 15 seconds on each scene if the user spends longer then the video length of the scene the video is looped back to the start.
Some of the scenes have the option to select an audio button from the menu. The audio description is a brief summary of the scene the user is currently viewing. The audio option can be utilised through speakers on the smartphone or through a pair of headphones/earphones. In our prototype, the audio was recorded using the default voice recording app on an iPhone. We then had to convert these files as they were stored as M4A files which Unity does not support. We used a website called zamzar to convert the M4A files to MP3 files. We then imported the files into Unity as a sound asset and connected this to the audio button that plays the audio description when selected.

The videos displayed are ones we filmed ourselves on the campus using a Samsung Gear 360. The Samsung Gear 360 camera records in 4k quality so that the end result is as close as we can get to actually being there in person. We planned out each tour before we started filming to identify the areas of most interest to capture. We then recorded those selected areas using the camera which was connected to a tripod and controlled using a smartphone.
Our app also offers virtual talks and tutorials that colleges may want to showcase to prospective students. This adds another aspect to our app to allow users to feel more immersed and as if they were attending the talks provided at an open day. For our prototype we will include a virtual talk by a lecturer in DCU similar to one a prospective student would receive at an open day.

Software Architecture

Prototype Version



Our product has five points of communication which work together to deliver Virtual Tours to the end user. These are:

- The user
- The user's smartphone (Android or IOS)
- Our application

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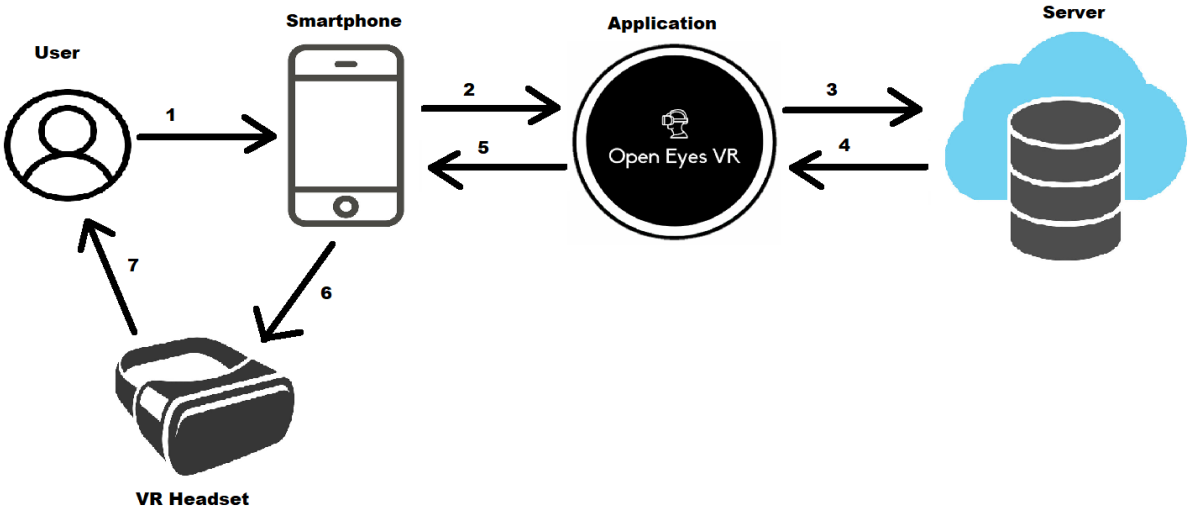
- ➢ The installed content that comes with the application
- ➢ The users virtual reality headset (Google Cardboard)

The process works by each point of contact communicating to the next. These contact points are the core foundation in which our product works, if one of the communication chains are broken, the tours will not be shown. The interaction between them is divided into seven steps:

1. The user opens our application on their smartphone.
2. Once the application is opened the menu is displayed on the screen. Our main menu/homepage for our prototype displays a 360° video recording of the DCU sign. An interactive menu is displayed below the sign which shows the different tours that are available and the virtual talk
3. The selected tour/talk is found in the storage and loaded.
4. The first scene of the tour/talk is loaded.
5. The first scene of the tour/talk is displayed on the smartphone
6. The tour/talk is shown to the user through the VR headset
7. The user views the tour.

In our final release version, we will have one change to our process. Instead of the content being stored internally along with the app, the content will be streamed from a live server to the application. This will reduce the size of our application allowing us to offer more content to the end user and enabling them to choose from a wider variety of tours creating a more personalised experience.



Prototype software

Our app prototype works on Android devices which meet the system requirements, that is that the device has enough free storage and an API level equal to or greater than 19 (Android KitKat). Our prototype can be installed on the device by downloading our APK and connecting your device to a PC and transferring it into the storage of the device. After transferring and installing the APK, a shortcut of our app is then added to the applications tab, displaying both our logo and the application name.

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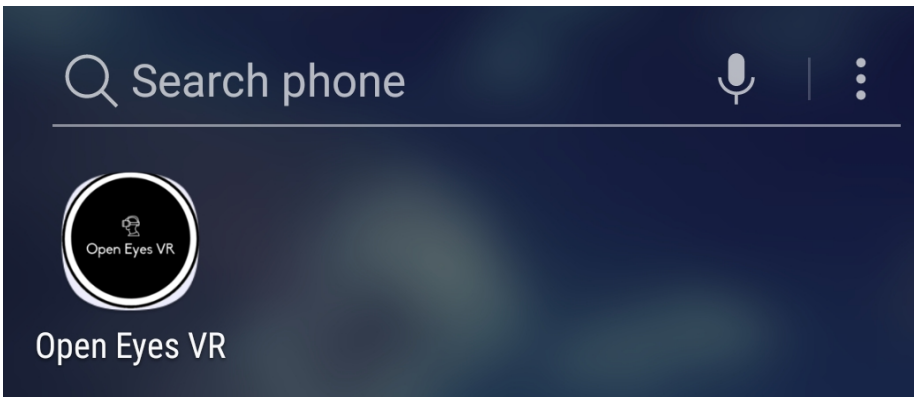
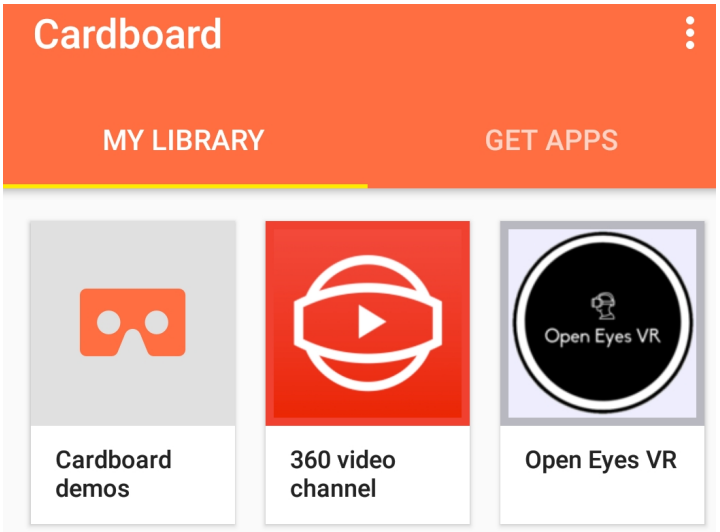


Alternatively, if you have the Google Cardboard app installed on your smartphone, the application will automatically be added to your library and is accessible through that app.



When the user opens our app the virtual reality mode will start up and an image of our logo will be displayed before advancing to the main menu.

Main Menu

Our main menu is the first virtual scene that is displayed after the loading screen. The image is duplicated so that each eye can see and process the image. The scene is where the user can choose which tour they want to view on our application. The background is a 360 video that was recorded of one of the DCU signs as it is one of the first landmarks many students see when entering the DCU Glasnevin Campus. There are five main points of interest in this scene:

1. The small white dot is displayed in the centre of the screen at all times. This is the reticle that allows the user to choose the different options throughout our application. As the user moves their viewpoint around the 360 video, the reticle stays in the centre. When it passes over a button that can it can interact with the button is highlighted. The user can then select the button by pressing down on the physical button located on the top right of the Google Cardboard.

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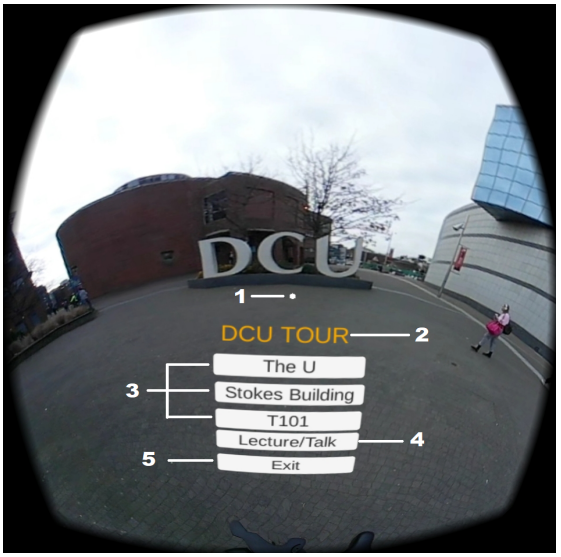

2. The title of the tour the user is viewing is displayed here. Since our prototype is only of DCU, this is the only instance of this heading. In the future when a variety of colleges are available on our app this feature will allow the user to easily identify which college tour they are viewing.

3. These buttons are the virtual tours of building on the DCU Glasnevin campus. Firstly we have the new Students Union building "The U", followed by the new "Stokes Building" and lastly "T101" the largest lecture theatre on the Glasnevin campus. To select a tour the user moves their head so the reticle hovers over the button. The button will then be highlighted red, once the user selects that tour by using the button on the Google Cardboard headset it will change from red to green and the tour will be loaded.

4. This button works the same as the previous three buttons, once selected it will load a virtual lecture.

5. This button allows the user to exit and shut down the application, bringing the user to their homepage or default app page on their device, depending on what was last used by the user.

Virtual Tour

This image is taken during a live version of our application, when the user had selected "The U" option from the main menu. The virtual tour is then loaded and the user is placed into the first scene of the tour. The user can experience different rooms and areas within the building. The main area of interest in the tours is the interactive menu system that works just like the main menu system (the user hovers over a button with the reticle and selects it by pushing down the physical button on the headset). Our menu system has the following options including the exit button that has the same functionality as in the main menu.

1. The home button ends the virtual tour the user is currently taking and returns them to the apps main menu. The user can then pick another tour/talk or to exit the app.

2. The previous and next buttons change the scene the user is experiencing to the previous or next scene. This is how the user can navigate through the tour and experience the different rooms or viewpoints. If the user selects the previous option from the first scene in the tour then the last scene and when they are on the last scene and select next the first scene is loaded.

3. The play and pause button relates to the 360 video that are being displayed. When you enter a scene the video is automatically playing but the user may want to pause.

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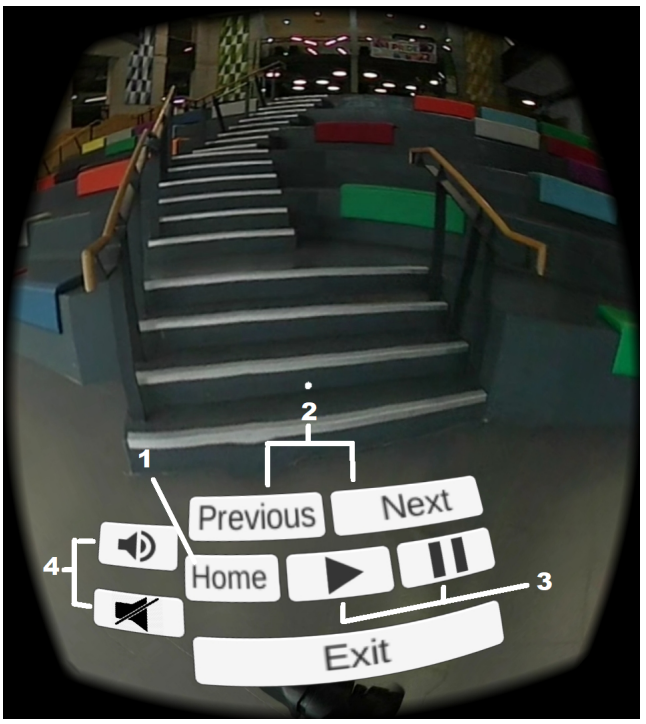
Selecting the pause button will stop the video. During this time the user still has full functionality to use the other features. To unpause the video the user can select the play button. We used icons instead of the words “play” and “pause” to make our app more user-friendly and more accessible to international students.



4. Some scene with the building tours have an extra piece of functionality which offers an audio description of the scene. If it is available for the current scene the user is viewing two buttons will appear to the left of the menu. To play the audio the user must select the speaker icon button, and the audio will be played through the speakers of the device or through headphones if they are connected. To stop the audio the user can select the cancelled out speaker button. Similarly to the play and pause buttons, we used icons so that they could be universally understood.

Virtual Lectures / Talks

The virtual talk works similarly to the other tours however there are some differences. The audio and video aspects play automatically once the scene is loaded. The video and audio are connected and therefore there are not two separate options for playing or pausing. When the user selects the pause button both the video and audio are paused and vice versa with the play button. This is to ensure that there are no issues with them being out of sync. The user can restart the lecture at any point by selecting the “Restart” button which will reset both the video and audio to the beginning. Since there is only one continuous video feed for the lecture, there is no need for a system to be able to navigate viewpoints.

Technical Roadmap

This is a view of one of our scenes within the development in the Unity Engine, with our asset hierarchy on the left and the model scene on the right. Each scene looks similar to this one and is made up of five main components and within these components there can be a number of different components, assets or scripts.

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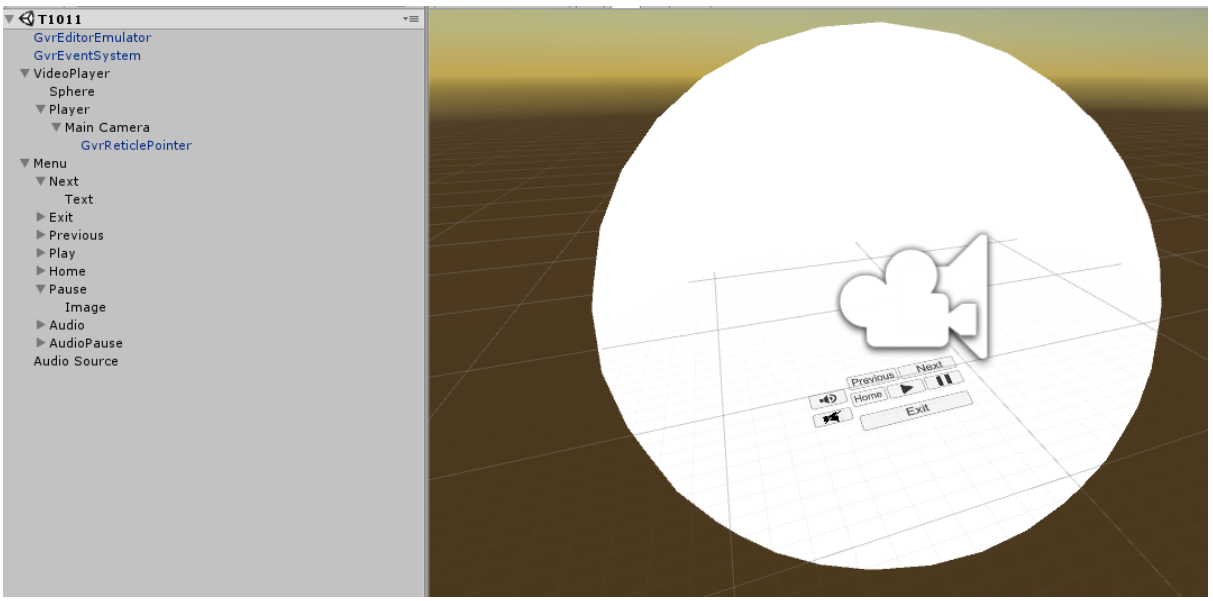

The five main components of one of our scenes are:

1. **GvrEditorEmulator**
   This is a prefab that comes with the Google VR SDK. It allows us to simulate the head movement and input within the Unity engine preview mode. By including this within our scenes it allows us to the test the scene on the Unity Engine and not have to create a new build every time we want to see the results of a change or test.

2. **GvrEventSystem**
   This is another prefab that comes with the Google VR SDK. It changes the default event system in Unity to a new system that is built for Google Cardboard/Daydream. The biggest change this makes to the system is that we are able to incorporate special input modules which allows us to use the cardboards physical button and reticle in our application.

3. **VideoPlayer**
   The video player component is a collection of different assets that allow us to show the 360 videos in our application. The main two assets used are our sphere and the player/main camera. The sphere acts as a canvas for our video which is displayed on the inside of the sphere using a custom made shader within the Unity Engine. So our video is then plastered onto the inside of the sphere as a texture which creates the illusion of being a 360 environment. Then we placed the main camera (which is what the user sees) in the centre of the sphere. This now puts the user perspective within the sphere where they are fully surrounded by the 360 video. The last component to the video player is the GvrReticlePointer that is added to the main camera as a child. This provides a gaze-based reticle pointer that can be connected to the Cardboard button input . This is what we use to select and navigate our app.

4. **Audio Source**
   The audio source is an asset that allows audio files to be stored and be called by the event system. Within the source, you can pick the different settings for the audio. For example, with the lecture, we need the audio to play from awake while with the audio

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buttons we only need it to be active when called. In our prototype, we are using mono sound output, but for the fully developed product, we would be looking to include spatial audio to give the user a stronger feeling of immersion.

5. **Menu**

   The menu is the one component that differs the most depending on the scene, the menu system is a canvas which allows the user to interact with the application by utilizing components within itself and those of the other main components. The menu differs depending on the user needs within a scene, for example, the main menu and a virtual tour both use a menu component but for different needs. The components for what is needed is added to the canvas as a button that then use the event system to complete a task. We have split the components into three different categories, app navigation, video settings and audio settings.

   The app navigation includes buttons such as “Previous”, “Next” and the tour selection option in the main menu. These work by using the event system and a script we wrote called SceneCtrl. When the button is pressed a specific scene in the build will be loaded and shown in the app. This allows the user to navigate the app by choosing what tour they want in the main menu or by clicking to see the next scene on a tour. Within the script, we also included a function called QuitApp that when called the application is closed, this is used for the exit button.

   The video settings include the play and pause functionality within the tour. These work by using a script that is included in Unity (VideoPlayer) and allows us to control a video that is displayed on an asset. By using this script and the event system we connected them to the sphere (the asset the video is on). Now when the button using this system is clicked a function of the script is ran. The functions we use are the play and pause functions which allow the users to control the 360 videos.

   The audio settings work quite similar to the video player buttons but instead of referencing the sphere with the video, we reference the audio source asset and an mp3 file. We then added the audio source asset to our event system of the button and selected one of the built-in function for audio. This allows us to play or pause the audio when a corresponding button is activated.

   One small thing to note in the canvas is that some of the buttons display as words while others display as an icon. Within each button it allows you to edit what is displayed on the button as long as it is either in text format or through an image that is saved as a sprite. As previously mentioned we incorporated icons as the buttons to allow our application to be more accessible for all users.

System testing

To test our application we installed it on three different Android devices, all with different hardware specifications and price points to make sure that it works for all users. Once installing it we ran a number of tests ourselves to make sure that the application runs as

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expected. For each device, we ran the application twenty times and used all the functionality at least once (ie. scene navigation, play/pause, audio functionality, etc).
For testing we used the following devices:

1. Huawei P9 Lite (lower end specs - current sales price of €130)
2. Samsung Galaxy S7 Edge (Medium specs - current sales price of €300)
3. Samsung Galaxy S10 Plus (High specs - current sales price of €1000)

Our prototype worked on all three of these devices with all of the core functionality working as expected, but there were a few differences in performance.

Huawei P9 Lite
This device had arguably the biggest difference in performance to its counterparts. First of all, this device overall was a bit slower when running the application. This is probably due to its relatively slow CPU and only 3GB of dedicated RAM. The most obvious way to observe this was in the time it took to change scenes. Sometimes it would take upwards of a second just to load the next scene which overall hurt the user experience and their immersion. The screen quality was also not great or as clear as the other devices. Everything is still able to be seen but at times it can appear more pixelated than the others. There were no application critical bugs that stopped the app from working and the application was able to function overall. All the problems with this device relate to the overall performance of the app on the device.

Samsung Galaxy S7 Edge
This smartphone was our main for testing the application through all the stages of our deployment. When testing the final version the application worked as expected with very little performance issues. The biggest thing of note though is that during two of our twenty tests, after using the app for over two minutes the application itself froze and had to be closed down. This happened at random points throughout the app and no causes were issued to our debugger. Further investigation into this bug proved that it was unable to be replicated as much as we tried it would just happen at random points (although very infrequently). As of this point, we have not identified the reason and therefore we have not been able to fix it. Other than this bug the application runs well overall with only a small decline in performance after extraneous continuous use.

Samsung Galaxy S10 Plus
Through all of our testing, we noticed no issues in functionality or performance with this device. Each scene loads fast and the overall quality of the videos are much clearer on the high-resolution screen. The only slight problem we had with this device was fitting it into our Google Cardboard headsets. The phone fits into it fine but when you include a case on top of the phone it becomes a much tighter fit. This was the only negative about using the S10 Plus to run our application as it never crashed for us unlike its Samsung counterpart in the S7 Edge.

This is all the testing that we have completed on the prototype but if we were to continue with the project we would need a lot more extensive testing on different devices. We only covered a Huawei device and two Samsungs so we would need to test on different brands as well as cover a broader range of specifications. We also need to further investigate the

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bug on the Samsung Galaxy S7 Edge to find out if it is our software that is causing the failure or the device itself.

Technical Challenges

We faced a number of technical challenges during the development process:

- It was our first time using many of the tools that were needed during development, for example, neither of us had experience developing for Virtual Reality and had never used Unity Engine which was our main tool for creating the app. The limited experience with C# also caused some challenges. Overall the lack familiarity with our tools caused a lot of problems especially early on. We resolved these difficulties by utilising courses available on websites such as youtube as well as those provided by Google and Unity. If we then faced any errors not covered within these courses we used Google and StackOverflow to try to find solutions for similar problems.

- As our concept revolves around filming, we had to ensure we complied with the data regulations. Our main concern was with the new EU data protection laws (GDPR). Originally we planned to film during times when the areas were not open, however after discussing with the head of marketing in DCU and Trinity they felt that would take away from the experience. Taking this feedback into account we had to find a way to ensure the tours did not feel empty and complied with GDPR regulations. We looked into how we could achieve this and found that once we gave adequate notice to the estates office in DCU with permission from our supervisor that we would need on hand during filming we were allowed to film on the campus.

- Storage is a major problem for us since we are using very high-quality videos which are extremely large in size, some of these clips range from 200-350mb in size. This has caused problems for us as we know that releasing a large application can cause you to lose potential customers. We have investigated ways of streaming the content to our application from an external server to stop us from having to store files locally. This is how we will be progressing for the final published version of our application. As of now though we are focusing on cutting down the size of the video files. For example, for our prototype, our videos are between 20 and 30 seconds in length and loop back after completion. We are also only incorporating a selection of the videos we have recorded to combat this problem for our prototype (11 different videos in total).

- Getting our application to be functional on a test device was a challenge. Unity offered a preview of the app however getting a build to work on a smartphone was a problem. This process took a lot of trial and error as it was the first time we have created a real functional application or program that was not being run by the computer but instead able to work on a separate device. Often bugs and errors would show up which would either cause the application to not run as expected or for the build to not transfer. For example, since we are using an Android device for our prototype we needed to install Android Studio and the Java Development Kit to use as an SDK and JDK when compiling the build. Sometimes bugs would appear that would cause the app to function very slowly or at times cause the app to freeze

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completely. We were not able to replicate these bugs as they would happen at random and would not send a report to our debugger. After time these started to happen less frequently and appeared to happen more so on devices with lower hardware specification leading us to believe that these bugs were caused by the hardware of the test devices.

Research and Development

We conducted a lot of research for our idea so that it is feasible and accessible. With Virtual Reality still in its infancy, we are limited in ways to create a truly immersed experience for our end user, for example, we still have to rely on a camera being in a fixed location and switching the scenes. Our end goal is to make a product that will give the user the feeling that they are on a college campus being given a tour that is just as good or better than one they would receive at an open day. To do this we believe that the user has to be able to move freely across every square foot in a 3D environment. The technology is not there yet that would allow us to create this nor is it feasible for the users to be easily able to access the tools needed. We believe the first step in achieving this is getting what we currently have developed onto the market so that people can see that beneficial uses of Virtual Reality, especially with something as important as choosing a college or place to gain a higher education.
For the future development of our app we would like to look into:

- A more extensive view of a college and increase our number of options available for the user. As of right now we only have one college with three tours available and one talk. We would be looking to add as much content as possible to make the app more useful to the end user. This would involve us reaching out to other colleges with our prototype to demonstrate what can be achieved through virtual reality tours of their college campus'.

- Getting our application up and running is our main aim, however, there are also alternative ways for the end user to view the virtual tour. Creating a version of our application that would be available in web browsers or as a downloadable computer application would allow users to experience it through different headsets by connecting them to the computer. Right now our tours are available through the use of Google Cardboard and can be modified for Google Daydream. We would continue to work towards getting cross-functionality with other headsets such as the HTC Vive and Oculus devices.

- Currently, we are running the application off the content/assets being installed with the application. This works for the prototype to show that the application is functional, but would not work with our published version. The APK is too large and we would not expect the users to download an application of that size. By including assets such as the video and audio, it is almost 3% of the total size of the app. We have been working to create the app so that the video and audio assets are streamed from a cloud server to reduce space. In relation to the final version of our prototype we have not been able to get this feature to work, however, this will be our main focus for the future.

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- There are some new ways to utilize VR that are starting to become popular. Social media platforms are starting to allow for VR videos to be shared on their platform (such as Facebook). Although these currently only allow for singular videos to be uploaded, we could look into uploading snippets of our tours as a form of marketing for our app.

- Better optimization of our application is a continuous process and never fully completed. From a technical standpoint, we would look into better storage techniques that would allow us to make our app bigger without hampering the performance or improve the transition between scenes.

- Making our application compatible with a variety of languages in an aspect we will be looking into, especially since one of our main markets is international students. Providing subtitles or language selection for users depending would enable our app to be more user-friendly. Another way would look at to make our application more user-friendly would be to replace the words in our menu systems with symbols such as a pause button instead of the word, which would cut down the amount of translation needed.

- For our application to be downloadable from a variety of common app stores. It is relatively easy to get our application onto the Google Play Store which accounts for most of the Android Market, however, there is a long process to get your application onto the Apple App Store which would allow us onto IOS devices. As well as these platforms we will work on getting our application on specific international app stores such as Tencent MyApp to get into the Chinese Android market this would require a partnership with a Chinese publisher for that region.

Description of technologies used

- Unity Engine: We are using the Unity Engine to build our application and 360 environments. Within this, we are combining all of our other technologies to build assets, scenes and environments that are then transferred to a mobile device through a USB connection.

- C#: C# is the language we used to write our scripts for the Unity Engine as C# is the default language in Unity. We have one vital script written in C# that turns materials placed on assets on the inside of the shapes in our environments. This is needed so that we can create the perspective of having a full 360° view by placing the users view within a sphere that has the video placed on its inside. We also needed to create a script that allows us to change scenes (ie. with the next and previous buttons) for the navigate of our app.

- Google VR Software Development Kit: This SDK provides assets and API's that allow you to create for either Google Cardboard or Google Daydream. Since we are developing using Unity we used the SDK version built for that. This SDK allowed us

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to use the features of our application when using a cardboard headset such as user input and made it easier to build for our headset.

- Android Studio: Android Studio is an Integrated development environment (IDE) that we used to configure our app for building and deployment on to Android devices. We didn't develop using the platform itself but combined it with Unity as an SKD which allowed us to build within Unity for Android devices.

- Java Development Kit: WHile we are building our app using Unity to build for Android it needs to compile Android resources from the Android libraries which in some cases are java files. We needed to install the latest JDK so that our app would build and work on our devices.

- Visual Studio 2017: Visual Studio is what we mainly used to write the code we needed such as our C# scripts. This came with the install package for Unity and was the default selection when selecting to create scripts in Unity.

- Samsung Gear 360: This is the camera that we used to film our 360° tours of the college. We recorded using this camera mounted to a tripod, then transferred the videos to a PC where they would then be imported to Unity. These videos are then placed onto the inside of a sphere using a script as a texture.

- Zamzar: Our audio files were recorded using a default voice memo app on an iPhone which saves the files in an M4A format. This was a problem for us since Unity does not support M4A as an audio source, to combat this we uploaded the audio files to Zamzar to convert them into MP3 files. This allowed us to incorporate them into Unity.

Source code

Many of the core functionality and scripts that we needed to create for our application were included within either Unity or the Google VR SDK we had previously installed. The majority of our application was created by learning how to use these tools in the Unity Engine and applying them in our environment as well as adjusting them to fit our needs. Our project did not fully revolve around coding a program from scratch but instead using many different tools provided within Unity to create the app. There were some features that were not included that we had to make scripts to utilise them. To create these scripts we first had to learn how to program in C# as this is the main language used in Unity. We used online resources and tutorials [Reference 8]. We also used online resources such as Youtube for videos and guides on how to create a VR application these provided insight and open source code we were able to use as templates.

Video control script

This C# script allows us to connect the buttons in our app to the specific video textures that are displayed. This enables users to pause and play the 360 videos by interacting with the buttons.

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```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.Video;

public class VRVideoPlayer : MonoBehaviour
{


    private VideoPlayer videoPlayer;

    void Awake()
    {
        videoPlayer = GetComponent<VideoPlayer>();
    }

    void Start()
    {

    }

    void Update()
    {

    }

    public void PlayPause()
    {
        if (videoPlayer.isPlaying)
        {
            videoPlayer.Pause();
        }
        else
        {
            videoPlayer.Play();
        }
    }
}

```

Scene Changer Script

This script is a simple C# script that was created to allow us to change the scenes by interacting with the previous and next buttons. This enables the user to navigate through our application as well as providing a function that allows the user to close the app at any point by selecting the exit button.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class SceneCtrl : MonoBehaviour {

    public void ChangeScene(string sceneName)
    {
        SceneManager.LoadScene(sceneName);
    }
    public void QuitApp()
    {
        Application.Quit();
    }
}

```

Texture script for showing video on the inside of the sphere:

This is a shader file that we used to flip the video texture on the sphere to be shown on the inside. We used a version of this script that we found in an online tutorial [Reference 18] and modified it to work for our application.

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```
Shader "Flip" {
Properties {
    _MainTex ("Base (RGB)", 2D) = "white" {}
}

SubShader {
    Tags { "RenderType"="Opaque" }
    Cull front
    LOD 100

    Pass {
        CGPROGRAM
            #pragma vertex vert
            #pragma fragment frag

            #include "UnityCG.cginc"

            struct appdata_t {
                float4 vertex : POSITION;
                float2 texcoord : TEXCOORD0;
            };

            struct v2f {
                float4 vertex : SV_POSITION;
                half2 texcoord : TEXCOORD0;
            };

            sampler2D _MainTex;
            float4 _MainTex_ST;

            v2f vert (appdata_t v)
            {
                v2f o;
                o.vertex = UnityObjectToClipPos(v.vertex);
                // VR360TV:
                v.texcoord.x = 1 - v.texcoord.x;
                o.texcoord = TRANSFORM_TEX(v.texcoord, _MainTex);
                return o;
            }

            fixed4 frag (v2f i) : SV_Target
            {
                fixed4 col = tex2D(_MainTex, i.texcoord);
                return col;
            }
        ENDCG
    }
}

}
```

User Testing

We conducted user testing on prospective end users that attended the DCU Spring Open Day, this involved the prospective student demoing the current version of our app. This version had virtual tours of the U building, T101 and the Stokes building, it did not yet have the audio or virtual talk incorporated. Once students had demoed our app through the Google cardboard headset we got them to fill out a survey we had generated using 'Survey Monkey' and all the data collected was anonymous. The survey was designed to get feedback on any improvements to our app the end users felt necessary and to see if they would be interested in using our app as a way of viewing prospective college campus'. Based on the results from our survey we found that 100% of all 40 students we surveyed we interested in using our app as a way of viewing the college campus and they also would all recommend it to a friend. In relation to any improvement, we could make based on on the end user's feedback we found participants want more building to see, audio (which would be included in the next version of our app) and the ability to move freely within the app.

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Survey Results: [Reference 19]

We also conducted user testing on prospective customers of our app. We met with the Director of the International Office and the Global recruitment manager as well as the Head of marketing and a member of the recruitment team in DCU. We offered them the opportunity to demo our app and give us any necessary feedback on improvements we could make. During these meetings, we asked them for feedback in relation to the usability and feasibility for DCU as a marketing tool.

In our meeting with the head of marketing and recruitment team we got the following feedback, in relation to events they would potentially use our app for they stated it would boost their marketing potential at students fairs, visits to secondary schools and also as DCU has three campus' it would allow students to view the other campus' from another location. Other features they mentioned they would like to see included in our app if it was to be fully developed for DCU were in relation to getting the culture of the college campus across to the end user while also allowing them to be fully immersed in the campus atmosphere. In relation to developing a virtual tour for DCU, we discussed the college' budget based on our product pricing. They were interested in purchasing the additional feature of having a branded headset as an incentive to potential students, taking this into account we offered them a price of €26,100 for a virtual tour of 5 building, 2 talk, a yearly maintenance fee and the branded headsets. They said that they would have the budget available based on these figures but would only be willing to give such a sizeable chunk of the budget if the college had real input throughout the process of what was recorded and also included outside areas rather than just buildings. Overall they were really interested in using our app as a marketing tool for DCU as it also incorporated the brand of DCU as being an innovative college.

In our meeting with the director of the international office and the global recruitment manager, we got the following feedback. In relation to the ways our app could be potentially used by the international office they stated that it would be a great tool to send agents internationally to give them a sense of what they are promoting to the students, at student fairs it would be a great tool to attract students to the table and leave a lasting impression, useful for parents and guidance counsellors in the secondary schools, allow them to train staff for tours around the different college campus' and a great way for international students to get a sense of the college and its atmosphere before they register. As part of a broader marketing plan across the whole college, they said they could see our app having a great benefit to the colleges marketing perspectives but domestically and internationally. Other features they mentioned they would like to see was the ability for the user to freely walk through the campus in the virtual environment to get the concept of how to get from one building or area to another, as well as this they suggested a feature that would allow international students to view the campus location in relation to the Dublin area and city centre, they also thought it would be beneficial to have contact information for the students to know where to go or who to contact to find out more about the college or courses, and finally the suggested making the app access on multiple platforms as well as being able to function without an internet connection as at student fair or events it is not uncommon for the internet connection to drop. As in our previous meeting we discussed the cost breakdown of us developing a virtual tour for them, again we offered them a price of €26,100 for a virtual

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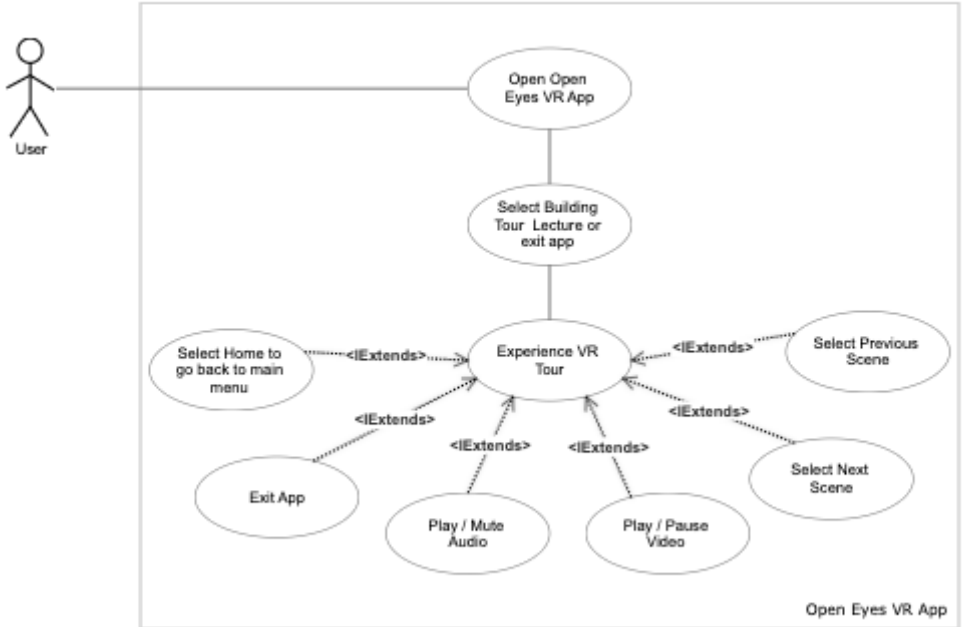
tour of 5 building, 2 talk, a yearly maintenance fee and the branded headsets as they were also interested in this concept. They felt the branded headsets would allow them to stand out more and be more memorable as students could potentially receive the headsets in place of pens at the fairs, this also builds on DCU's recyclability and sustainability branding concept. Based on our pricing they felt it was reasonable if it was to be used as a marketing tool across the whole college and not restricted to one specific department as it would exceed one department budget. They justified the price as our app would allow the college to target national and international students, guidance counsellors, parents and agents promoting the college and would effectively be paid off be obtaining the registration of two international students through the use of the app. Overall the feedback we received was positive and allowed us to identify the areas our app would need to be more developed to meet their requirements as well as being flexible with new technologies that will arise in the coming years. They saw great potential in our app for broadening their reach on the international market as well as the domestic market.

7.Functional Specification

Data storage requirements

The data gathered during development is stored internally in the application. For the prototype, the assets of the application (video, audio, menus) are stored locally in the storage of the device. The app itself is quite large since as it stores these assets, especially the videos. The prototype application is 1.6GB in size. For the application to be transferred to the device, there needs to be at least 1.6GB free memory, once the APK is installed this storage is taken up by the application.

UML Use Case for the Prototype



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User Personas

User	Details	Goal
Andre	French Student looking to study in Ireland 22 years Old Looking for a college with a good atmosphere Struggling to view and get a feel for potential college campus'	More interactive view of prospective colleges Get Information on courses and facilities View Resources on campus Get a feel for the college atmosphere

User	Details	Goal
Siobhan	Irish Student currently studying for leaving Certification exams 18 years old Can't afford to travel to multiple open days Moving away from home and wants to know the college atmosphere and campus will suit her	Receive more information on courses and facilities the college offers Get a feel for the campus atmosphere Have the opportunity to view multiple campus without expensive travel costs Ensure the college is the right fit for her

User	Details	Goal
Dublin City University	Open Days only offered twice a year Struggling to market to international students and national student who can't attend the open day Out dated marketing techniques Need extra staff for open day tours	Increase the number of students attending the college Improve marketing techniques to both national and international students Offer a more interactive experience to prospective students Stand out from competitors

External software interfaces:

The Current User Interface for our Open Eyes VR Prototype:

Main Menu

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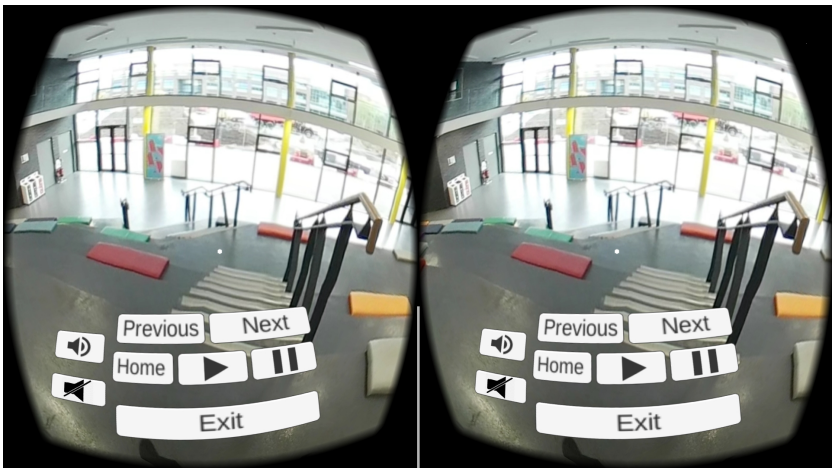
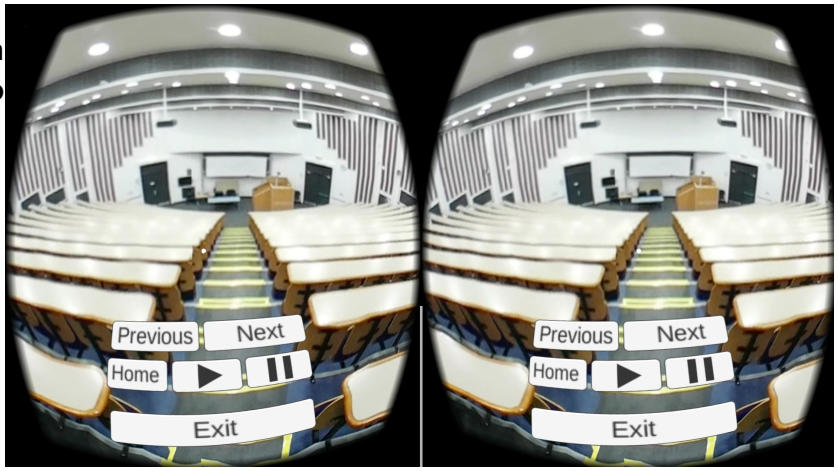
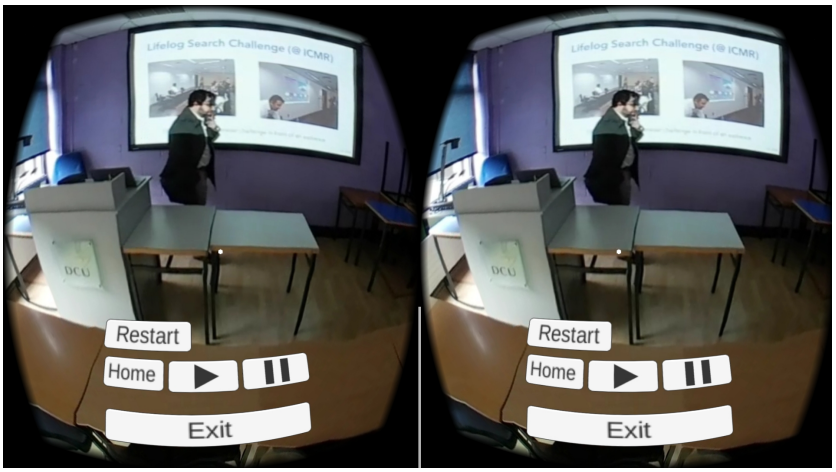
Virtual Tour scene which includes audio description



Virtual Tour, scene which does not include audio description



Lecture/Talk



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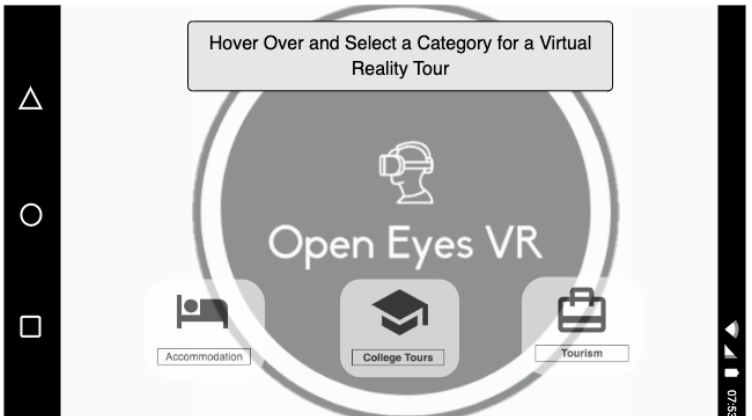
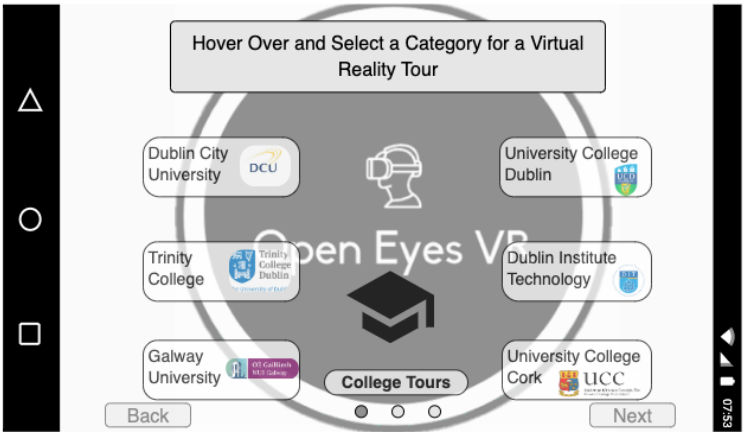
MockUps:

The mockups for the UI for our fully developed version of the Open Eyes VR app were designed using the web application Moqups.

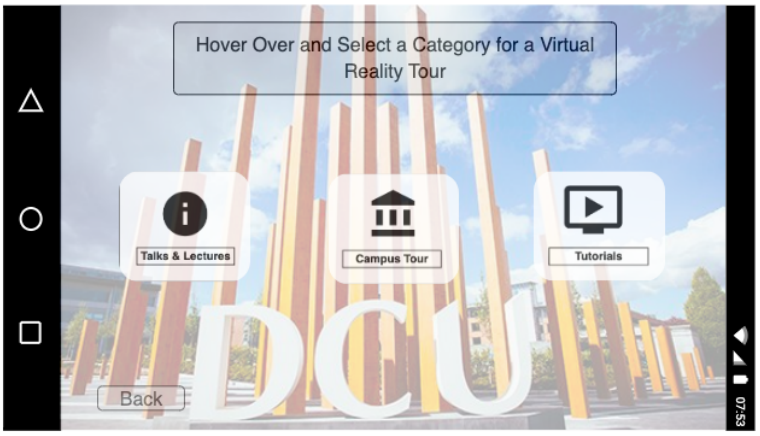
Fully Developed App Homepage:



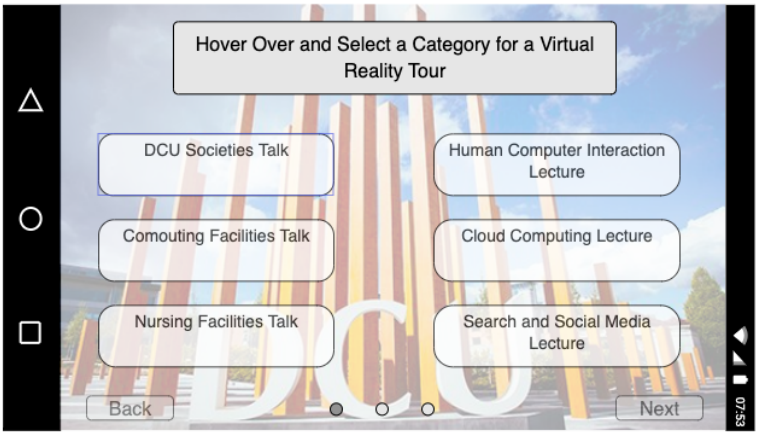
Fully Developed App College page:



Fully Developed App College Selection page:



Fully Developed App Lectures/Talks page:



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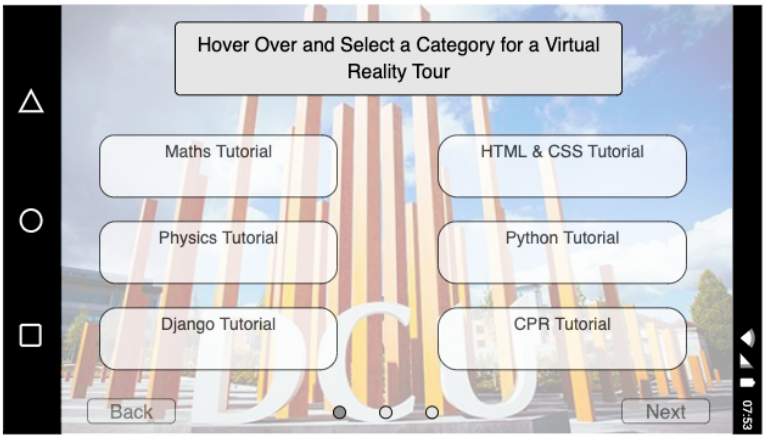
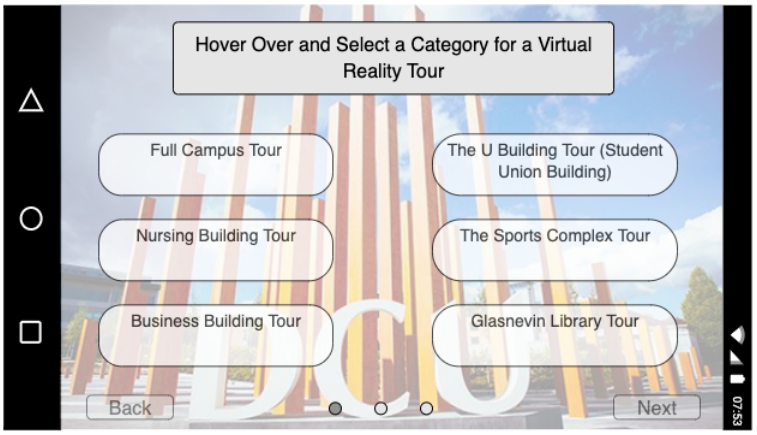
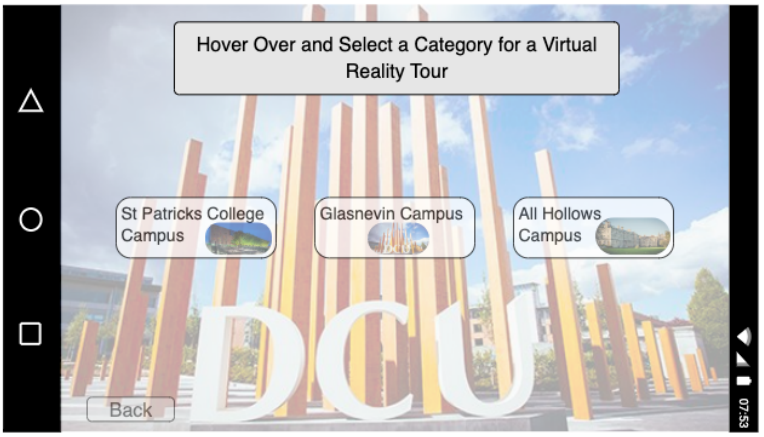
Fully Developed App Tutorials page:



Fully Developed App Campus page (if College has one Campus):



Fully Developed App Campus page (if College has Multiple Campus'):



Performance requirements of the software

For our application to run on a device it must meet a number of requirements.

1. The user's device must be an Android with API level 19 or greater, this means the operating system is at least Android 4.4 KitKat.
2. The user must have a Google Cardboard or similar headset.
3. The device must have at least 1.6GB free on either their internal or external storage. This is needed to transfer the APK and then install the application. (With the inclusion of cloud storage later on this size will greatly decrease)
4. The application must be installed on the device.

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5. For audio output, the device must have either functional speakers or connect a pair of head/earphones.

Interface rationale

Our aim was to make our apps interface easy and accessible for all prospective users. As our app as aimed at the international market, we needed to find a way to break down the language barrier that may cause an issue when international users are using our app. To ensure our app was usable globally we incorporated universally recognised symbols for the majority of the features in our app. We opted for a minimalist interface with muted colours for the menu bar to avoid distracting the user when they are using the app. Another feature our interface that aids the user in navigating through our app is the highlighting of the menu bar when hovered over with the pointer, this always the user a better sense of their location and movements within the app, it also avoids error in selecting the wrong option. We also wanted our app to be accessible to those who are lacking in technical knowledge like parents of prospective students who want to view the potential college their child may attend.
Our simplistic UI allows our app to translate across multiple nationalities and ages enabling more prospective users to be able to navigate through it with easy creating an enjoyable user experience.

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8.Appendices

Appendices 1

Personal

Aoibhín Laverty

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LinkedIn: https://www.linkedin.com/in/aoibhín-laverty-b2591061
Mobile: 0860392963
Address: 29 Mill Street,
Dundalk, Co.Louth

Summary

Enthusiastic and energetic Enterprise Computing student at Dublin City University, interested in learning more about the application of IT solutions in modern organisations, especially how IT can improve the way people work together. I am hard-working, willing to learn and contribute as a Graduate and add-value to a business.

Personal Attributes

***High-Level of attention to detail**
***Good team player with ability to work on my own initiative**
***Focused and capable of working on multiple tasks concurrently**
***Able to think outside the box and use logic in terms of general troubleshooting/problem solving**
***"Can-Do" attitude and adaptable/flexible regarding my work duties/responsibilities**

Education

2015 - Present — Dublin City University, B.Sc. in Enterprise Computing, scheduled to graduate in November 2019

Current Grade: 1:1

2009-2015 — St. Vincent's Secondary School, Seatown Place, Dundalk, Co. Louth

Employment

AIG: 30 North Wall Quay, Dublin 1
Position: IT INTERN (Business Analyst) — **January 2018 to September 2018**
I worked in AIG as part of my 8-month Internship in 3rd year. I was in Production Services monitoring and running reports on tickets for countries with EMEA (Europe, Middle East, Asia and Africa). I ran the daily meeting with the lines of business based in India. I ensured tickets were on track to meet their service level agreement and chase up on tickets that were in risk of breaching their dates. I also ran general reports when managers required this and took the initiative to run a weekly report for my manager of all tickets pending her approval. I did the manual task of mapping tickets to a country as one of the ticketing system lacked this field which we needed for Governance reporting. I ran the governance call biweekly with Spain and Portugal.

Costa: Unit 7, Marshes Avenue, Townspark, Dundalk, Co. Louth
Position: Floor Staff/Trainee — **August 2017 to January 2018**
Costa is a well-known coffee Franchise. I started working here in August 2017 as floor and on the till.

Rumhouse: Park Street, Dundalk, Co. Louth
Position: Evening Floor Staff — **October 2016 to January 2017**
Rumhouse is an upmarket Gastropub located in the commercial centre of Dundalk. I worked there on evening shifts and dealt directly with customers by taking their orders and bringing their drinks to their table. I also clear up the empty glasses and any spills or broken glasses that occur.

BoyleSports: Eastern Bypass Road, Dundalk, Co. Louth
Position: Fon-a-Bet Agent — **October 2015 – April 2016**
BoyleSport is a well-known betting company. I worked here for six months as a Fon-a-Bet call center agent. I received calls from customers in Ireland and England and placed their bets for them, and I also dealt with any minor customer issues. I finished this job as the shift work hours were not compatible with my degree course.

Interests and Achievements

- Received a Junior Achievement Certificate for my Volunteer work during my internship. I helped out during Iwish and a Greenlight for Girls event in AIG both aimed at promoting STEM subjects to young girls.
- Volunteered to help incoming first year students during their orientation week this year.
- Received MY SAFE for team certificate while working in AIG, this involved a two day workshop and an exam after.
- Took part in the Mastercard Female Mentoring Programme 2016. I was assigned a mentor who advised me on cv tips, interview tips and encouraged me to research the fields in which I want to work.
- Completed 10 grades of Speech and Drama with The Leinster School of Music and Drama.
- ECDL Certificate.
- Bronze Medal in Gaisce.
- DCU Alumni Mentorship programme I also took part in a DCU mentorship scheme where a past graduate of DCU takes us under their wing and helps us in taking the first steps into the working world, much like the other mentorship.
- I have completed a Myers- Briggs Assessment to further understand my personality preferences. My type is ESFJ, which indicates a helpful, tactful, compassionate and orderly approach to work and the working environment.
- I completed Pathways to Success which is a 4 week programme to guide students setting goals, building resilience, self-confidence and create a strategy to creating success.
- In my free time I spend most of my time at the gym and taking part in events that push you beyond you limits, such as Tough Mudder in 2018

Referees

Available on Request

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Appendices 2

Sean Williams
6 Foxhill Lawn, Baldoyle, Dublin 13
085 2098387 seanwilliams712@gmail.com

PROFILE

I am a Final Year Enterprise Computing student in Dublin City University. I am passionate about technology, learning and working with people. Since starting in DCU, I have been a mentor in CoderDojo@DCU, working with children from 8 to 15, teaching them web development. I got to represent and be a guest at inspirefest fringe festivel 2017 as part of Coder Dojo. I have also helped out at two Coder Dojo Coolest Project events in the RDS, in 2016 I was a Volunteer/ Steward and in 2017 I was Social Media Manager for the event. I also completed a Nine Month Internship at AIG as part of my college degree working on a server migration project team for servers in Europe, the Middle East and Africa.

VOLUNTEERING

Coder Dojo DCU **January 2017 – Present**

- Mentor for kids and young adults (aged 7 – 17).
- Teaching in html and web design.
- Helping the ninja's develop their ideas to be displayed at Coder Dojo Coolest Projects each year.

League of legends – DCU Society **September 2016 - Present**

Current Event Manager for DCU league of Legends Society. (Job included planning and organising events, running events, communicating with members and fundraising.) -

Former Treasurer for DCU League of Legends Society. (Job includes managing our current funds, looking after the society bank account, dealing with sponsors and tracking of all expenses.)

Current head coach for DCU League of Legends Team in Division 1 and Division 2 of the Irish Collegiate Esports Competitions.

WORK EXPERIENCE

American International Group, IT Project team **January 2018 – September 2018**

- Worked on the Windows 2003 Migration project for the EMEA region.
- I looked after and managed the decommissioning of old windows 2003 servers throughout EMEA.
- I worked alongside the project managers assisting with the migration of apps and preparing them to be moved over to new servers.
- Managed and looked after the project SharePoint
- Ran a programming workshop for Greenlight 4 Girls event to inspire young females to get involved in STEM subjects.

Royal Victoria Eye and Ear Hospital, IT department **February 2015**

- Worked as part of a team maintaining the hospital systems. This involved looking after upgrades, and hardware tracking.
- I maintained the hardware asset database.
- I worked with staff providing system support.

Irish Rail Credit Union **June 2014 – August 2014**

- Working with customers, assisting them with their cash lodgements and withdrawals.
- Administration duties, such as, validating data in the system or ensuring data is filed correctly.
- Cleaning and organising the office.

ACHIEVEMENTS

- Finalist in CITI Upstart programme 2019 for 4th year project (Open Eyes VR)
- Fetac Level 5 Merit in computer programming (2012).
- 6th Year AIB and St Paul's College Business Student Award 2014.
- Class rep for Computer Science 1B in Colaiste Dhulaigh .
- One of the founding members of the DCU League of Legends Society.
- Completed Junior and Leaving certificates attending St Paul's College, Raheny,

Projects

- An application that provides VR tours of college campuses through VR headsets connected to mobile phones. Project is for my final year project as well as the CITI Upstart programme where we placed in the top 10.
- Banking application that stores and accesses users accounts and provides a UI for the user to perform banking tasks.
- A web application that provides the user with real time information from DCU carparks and how many spots are currently available.

EDUCATION & TRAINING

Dublin City University **Enterprise Computing**

Fourth year semester 1 results received, was a 1:1	February 2019
Third year results received, was a 2:1	August 2018.
Second year results received, was a 2:1	August 2017.
First year results received, was a 2:1	August 2016.

Colaiste Dhulaigh, Coolock, Dublin 17 **September 2014 –2015**

Computer Science Fetac Level 5 and 6
Achieved distinctions in the following subjects,

- Communications,
- Spreadsheet methods,
- Maths for computing,
- Computer programming:
- Computer architecture:

IT SKILLS & LANGUAGES

- Python – Very Strong
- Html – Very Strong
- SharePoint – Very Strong
- MySQL – Very Strong
- Unity Engine – Very Strong
- Microsoft Office Apps – Very Strong
- Github – Very Strong
- Java - Strong
- Javascript - Strong
- CSS – Good
- Php - Good

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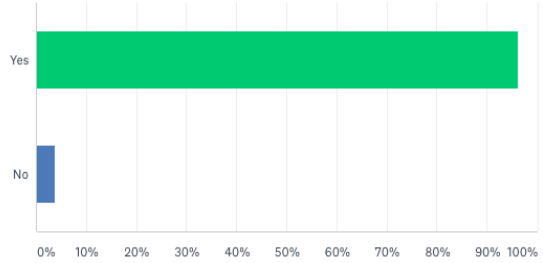
Appendices 3

Would you be interested in a Virtual Reality tour of colleges in Ireland

Answered: 78 Skipped: 2

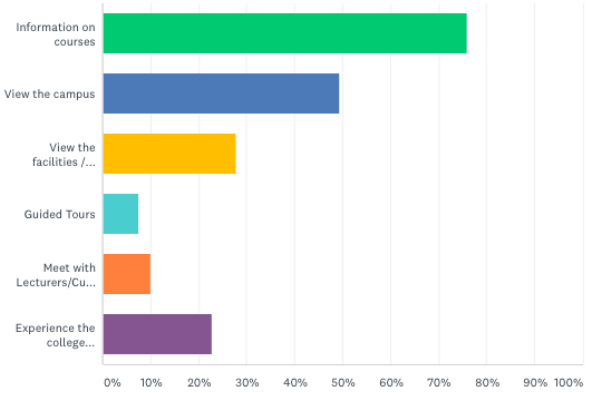


ANSWER CHOICES	RESPONSES	
Yes	96.15%	75
No	3.85%	3
TOTAL		**78**

Appendices 4

What did you hope to gain from attending the open day

Answered: 79 Skipped: 1

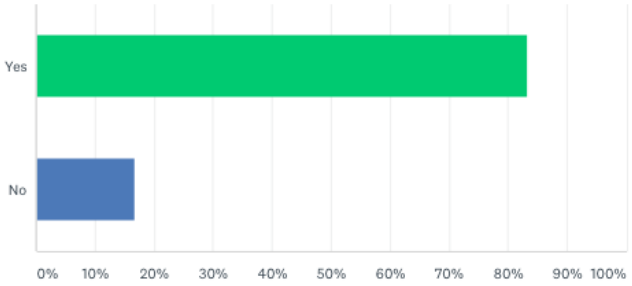


ANSWER CHOICES	RESPONSES	
Information on courses	75.95%	60
View the campus	49.37%	39
View the facilities / resources	27.85%	22
Guided Tours	7.59%	6
Meet with Lecturers/Current Students	10.13%	8
Experience the college atmosphere	22.78%	18
Total Respondents: 79		

Appendices 5

Do you think Virtual Reality Headsets will be common within the next 5 years

Answered: 12 Skipped: 0

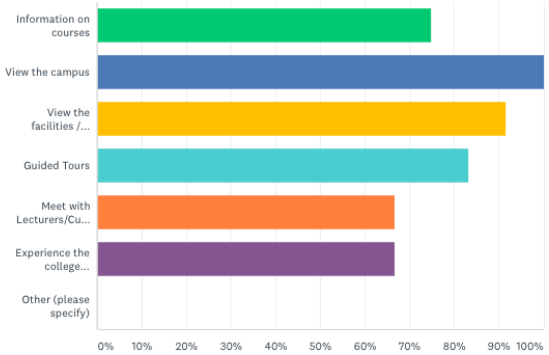


ANSWER CHOICES	RESPONSES	
Yes	83.33%	10
No	16.67%	2
TOTAL		**12**

Appendices 6

What would you have liked to see in a college tour

Answered: 12 Skipped: 0



ANSWER CHOICES	RESPONSES	
Information on courses	75.00%	9
View the campus	100.00%	12
View the facilities / resources	91.67%	11
Guided Tours	83.33%	10
Meet with Lecturers/Current Students	66.67%	8
Experience the college atmosphere	66.67%	8
Other (please specify)	0.00%	0
Total Respondents: 12		

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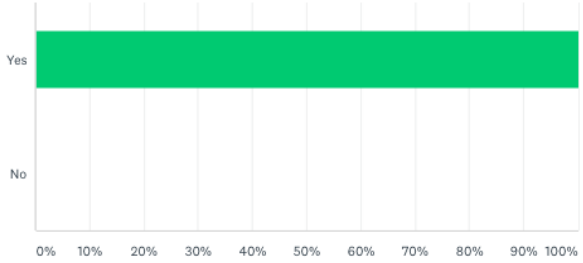
Appendices 7

Do you think Virtual Reality tours will help DCU in marketing to international students

Answered: 12 Skipped: 0

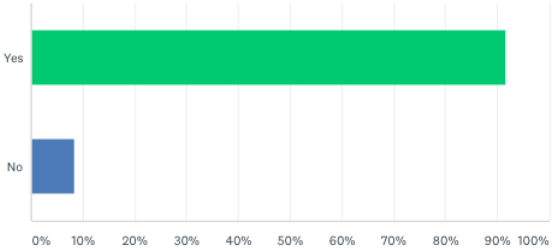


ANSWER CHOICES	RESPONSES	
Yes	100.00%	12
No	0.00%	0
TOTAL		12

Appendices 8

Would you be interested in Virtual Reality tour of colleges in Ireland

Answered: 12 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	91.67%	11
No	8.33%	1
TOTAL		12

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