Creation of a Scientific Podcast

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Contents

Important notes

Please note that all images or screenshots are my own, unless otherwise stated and credited.

Text in **bold** have been defined in the glossary

Links to access to following content:

- This dissertation in PDF form:
  `http://thomas-holland.me/epq/dissertation.pdf`

- Podcast (first version) audio file:
  `http://thomas-holland.me/epq/podcastv1.mp3`

- Podcast (final version) audio file:
  `http://thomas-holland.me/epq/podcastv2.mp3`

Glossary

Amplitude (also **Volume**)

The level or magnitude of a signal which affects the volume. Audio signals with a higher amplitude will sound louder. It is measured on the logarithmic scale, decibels (dB).

Audio mixing

Is the process of taking recorded tracks and blending them together with the aim of bring out the best in the audio track recording.

Audio profile

A sample audio that contains information about the volume levels and frequencies that make up a specific noise.

Bitrate

The rate at which binary information (bits) are transferred from one location to another, it measures how much data is transmitted in a given amount of time.

Clean audio

Is audio that is free from any distracting sounds or frequencies.

Clipping

when an audio signal is amplified past the maximum allowed limit, whether in a digital or analogue system. This is called 'overdrive' and it leads to distortion and reduction in audio quality.

Dynamic range

Describes the difference between the quietest and loudest volume of an audio track.

Ecosystem

A complex network or interconnected system of devices.

Editing

To remove or correct unnecessary or inappropriate material from a text, film, or radio or television programme.

Frequency

Audio frequency determines the pitch of a sound. Measured in hertz (Hz), higher frequencies have higher pitch.

Intervention (medical)

A medical procedure directed at or performed on an individual with the objective of improving health, treating disease or injury, or making a diagnosis.

Mass vaccinations programs

Involves delivering immunisations to a large number of people at one or more locations in a short interval of time.

Mastering

A form of audio post production, it is the process of preparing and transferring recorded audio from a source containing the final mix to a data storage device.

Meta-data

Descriptive information about a resource. It is used for discovery and identification. It includes elements such as title, content, author, and keywords.

Plug-in

A software component that adds a specific feature to an existing computer program.

RSS feed

A web feed that allows users and applications to access updates to websites in a standardised, computer-readable format.

User interface

The user interface is the point of human-computer interaction and communication in a device. It is the way through which a user interacts with an application or a website.

Volume

See **Amplitude**.

White noise

Random background noise not intended to be in an audio recording, which can make the recording harder to hear.

Section 1

Introduction

1.1 Introduction to podcasting

The Podcast Industry has been rapidly increasing over the last ten years. In 2018, Ofcom stated that over 6 million people listen to podcasts each week in the UK [1]. In the same year, Apple, a major podcast distributor, stated that it had over half a million podcast shows available on its platform [2], each containing several episodes.

Podcasts are different to normal content delivery. Normally, media such as videos are distributed on the same platform that they are hosted on, however podcasts are hosted and then distributed via an **RSS feed** that keeps the user's podcast application, such as Google Podcast, Apple Podcast or Spotify [3], up to date with the latest releases of the podcast [4].

The basic process for creating a podcast is to record the content, post the audio file and then add the link to the file on a registry which provides the content to the user. However there are more steps in the production that enable a better podcast to be made, such as editing and scripting [5].

1.2 Aims and goals for the project

My overall goal for this project is to produce a well researched and interesting podcast that gets positive feedback response from listeners.

To best accomplish this I split my project aims into two sections. The first were general aims and the second were personal development aims that I wished to complete.

My general aims were:

- To create a scientific podcast.
- To use the podcast as a medium for unbiased debate of medically relevant ethical topics.

- To provide the listener with researched information.
- To create referenced show notes that allow the listener to carry out their own research.

My personal development aims were:

- To develop in researching and presenting arguments.
- To develop my speaking skills.
- To develop my audio editing skills.
- To explore the podcast creation process.
- To research academic topics through a more informal and personal medium.

I will measure the success of this project in Part III on page 31. I will judge each of my aims and conclude if this project was a success.

I will ask for feedback from a person who has experience in this area and from people who have listened to my podcast. This will be documented in the relevant feedback sections.

Part I

Podcasting method

The original process that I planned for the creation of my podcast episode.

Section 2

Preparation for a podcast

2.1 Developing the podcast series concept and title

I wanted to create a podcast series debating topical medical ethical issues. I liked the idea of not always being able to get a right or wrong answer, as there often seems to be lots of wrong answers but very few right answers, that often the solution is a blend of differing opinions, sometimes leading to often deeper or more polarising questions.

I wanted a podcast series title that reflected the two sides to a balanced discussion and the importance of debate when the problem is caused by having only 'grey' solutions to an issue; and to reflect that ideas and concepts may mean more than one thing to different people.

I decided upon 'Medical Grey Matters' as this encapsulates the concept as well as having a playful double meaning with the expression 'Discussing questions which don't have black and white answers'

2.2 Research for the podcast content

This section is about selecting the topics used and the methods I use to formulate this into a script. For more information on how I validated the sources I found please read section 10.1 on page 35.

The topics that I chose to cover were largely down to personal interests. I chose topic areas that I was familiar with, as this would allow me to feel more natural when talking around the topic and discussion points. This had the added benefits of increasing the speed of researching.

My first stages of research was to formulate a list of possible topic areas. This involved loading up recent articles on scientific news sites. This was then expanded as I explored other articles and journals around the topics to explore the viability of the chosen podcast areas. I also listened to other scientific podcasts and TV programs. From that I decided on a few topic

areas and expanded my general questions to give an outline for the episode. At this point I proceeded to create a script from this outline.

2.3 Scripting

One of the main decisions when preparing a podcast is the style and depth of a script [6]. It is suggested that each podcast needs to find the ideal location along the spectrum of depth of script as 'Scripting can be viewed as a spectrum, with "fully-scripted" and "not-even-slightly-scripted" covering each end.' [7].

The need to select the correct amount and style of scripting is important to avoid not being prepared but also not too formal [8] as podcasting has been described as one of the most intimate information delivery methods. It is also important to build a bond with the listener as the podcasting format is a 'genre of audio narrative feature centred on a strong relationship between host and listener' [9].

There is not a 'one size fits all' approach that a podcast host can take, and there are lots of factors that need to be taken into consideration including [8]:

- How formal or informal it should feel.
- How much of the content is detail and information related.
- The amount that the script would need to be referenced during the recording for fact checking.
- The purpose of the podcast series.

However, one of the most important factors to consider is what the host is comfortable with as this will have a significant impact on how the finished podcast episode feels and how well it sounds. This will in turn impact the listener base and how long their attention is kept [10].

I chose to adapt a suggested format [8] for my needs. I chose this format as it has a logical layout that will allow me to provide the sources of information but also allow the listener to digest the information and follow the episode.

My chosen podcast format is:

1. Introduction

   This will include the name of the episode and the podcast title

2. Short summary introduction of the podcast

   This will give the main messages of the podcast and help inform the listener of what to expect. This will hopefully make the listener want to stay to the end of the podcast.

3. Situation/Topic 1

   This will include a main message as well as any examples that may be important or pertinent to this section.

4. Situation/Topic 2

   This will be focusing on a different area of a similar theme

   These will be repeated to answer the initial question. It may be directly related to the initial question but it may also be an important summary information that is necessary for the listener to fully understand the topic and provide background information.

   ...

5. A final summary

   This will present a summing up that is unbiased and impartial, and also a conclusion if a clear one presents. I may also include a further thinking point as a question.

6. Call to action

   This will be reminder that there is a link to the show notes, with the references, in the description.

7. Outro

   A 'thank you for listening' message.

Section 3

Audio track creation and manipulation

3.1 Software: Digital Audio Workstation

The main software tool used by podcast creators are Digital Audio Workstations (DAWs) [11]. This tool is used to record and edit the audio tracks that are combined into the podcast [12]. Each DAW has unique benefits and tools that enable an effective editing session, however there are a few negatives to each. As such, the choice between them is an important decision for a podcast creator, especially as several of the DAWs have their own file format, which makes them incompatible [13].

3.1.1 Choosing between the different DAWs for my project

My first selection criteria for the DAW was it had to be free, as there was no need to invest in professional grade software for a beginner podcast creator because the benefits gained do not justify the expense [14]. The two main free options for DAWs are GarageBand by Apple [15] and Audacity by the Audacity Team (and the Open Source contributors) [16].

The main reason to use GarageBand as a beginner podcast creator is the **user interface** is easy to learn and use [11] which would allow quick and simple creation of podcasts. Another reason for using GarageBand is the free audio library that is included in the software [17], which are royalty free [18] and so can be used in the podcast without payment. The last reason to use GarageBand is the ability to utilise the Apple **Ecosystem** and use an iPad or iPhone as a second screen for monitoring levels and other features [19], which would likely reduce the probability of having a clipped audio recording [20]. The only significant reason for a podcast creator to not use GarageBand is the lack of multi-track recording [19], meaning that there would only be one audio file for all the people being recorded rather than an

individual file for each person [21], which reduces the scope for editing and post-processing of the audio files.

There are also many reasons given to use Audacity as the DAW for a new podcast creator, the primary being the extensive user manual [19] which covers the large **editing**, **mixing** and **mastering** tool set [22]. The user manual also includes guides and tutorials which allow a new user to quickly learn how to get the most from the software [23]. Another major reason to use Audacity is cross-compatibility between Windows and MacOS, allowing the user to work across both operating systems [24]. The other major benefit of Audacity's Open Source nature [25], meaning that anyone is able to edit and see the code behind the DAW [26], is its large external plugin library which could increase the tool set of the DAW [24]. There are a few reasons, however, to not use Audacity one of which is the older user interface [17] which leads to a steep learning curve [19] which is not ideal for new podcast creators. Another is the lack of multi track recording, similar to GarageBand.

I chose to use Audacity over GarageBand because it was the best option for my project as it has the larger tool set and I believed the negative factors would have little impact on my workflow. An example of this is the older user interface, as there is an extensive manual which I am able to use to fully understand and utilise the tools that are relevant to my project. Due to me only needing to record a single track audio, as I did not plan to record anyone other than myself, the lack of this feature was not a concern. Although I had no plans on using the **plug-in** feature set, I believed it would be beneficial to have the option to expand my tool set as my project could progress, and something I could look to utilise if needed in the future.

3.2 Recording

There are several points and tips to increase the podcast quality. Ensuring a quiet working environment and a correct setup will lead to a **cleaner audio** file which is easier to work with later [27].

Methods to ensure this include using a small room with lots of soft objects that would act as acoustic panelling [28]. Also, using soft pillows and blankets behind the microphone will allow for there to be minimal reverberations and echoing into the microphone [29].

A helpful trick is to drink water to 'settle your stomach, loosen your mouth, and help your focus' [28] as well as to prevent 'ticking and clicking' sounds in the audio file originating from a dry throat [29], which are difficult to edit out and also are unpleasant to listen to.

The major aspect to monitor during recording is the audio levels. This is done to ensure that the file is of the correct **volume**, about -6dB. Below this, the audio quality deteriorates when the volume is increased and details in the voice can be lost. Above -6dB, the signal is approaching a dangerous level

(above 0dB) where **clipping** of the file may occur [23]. **Clipping** results in a distorted (blown out) sound as well as a loss of audio detail and clarity.

The manual for Audacity states that the 'bars remain green until the signal reaches -12 dB then merge to yellow as the signal approaches -6 dB'. Above the -6dB level the monitoring colour changes to red to indicate that the signal is approaching 0 dB [23]. This colour scale allows for easy visual monitoring of the audio levels whilst recording, with the ideal colour being just touching yellow. This is shown in Figure 3.1.

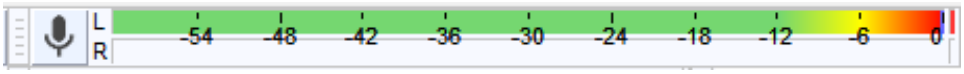


Figure 3.1: The full spectrum of the meter bar.

3.3 Editing

The focus of the research for this podcast was largely on single track editing, with little done on multi track editing, as the podcast was only planned for one track to be recorded which was the host track.

3.3.1 Removing silent sections

This part of editing is important as it will make the listener more able to follow the flow of the podcast episode.

In order to ensure that the episode feels natural, I chose against using automatic tools for this. By editing manually I can much better judge the impact that a silence may have, and also when to leave a pause in, to allow the listener time to digest the information. [30]

I chose to do this first to save time as the editor will not be fine tuning audio sections that would be removed. Also, it allows for me to have an overall feel for the flow of the podcast once I have recorded it.

3.3.2 Reducing clipping

In areas where **clipping** of the audio had occurred, I used the 'Clip fix' tool. Although this did reduce the quality of the audio track, the sound difference was negligible and therefore had no noticeable impact.

The steps to remove the **clipping** are to first identify the locations in the audio track where the clipping has occurred. This can be done with the 'Find Clipping Analysis' tool. The result of the tool will display the locations where the audio has clipped, as shown in Figure 3.2 and more magnified in Figure 3.3.

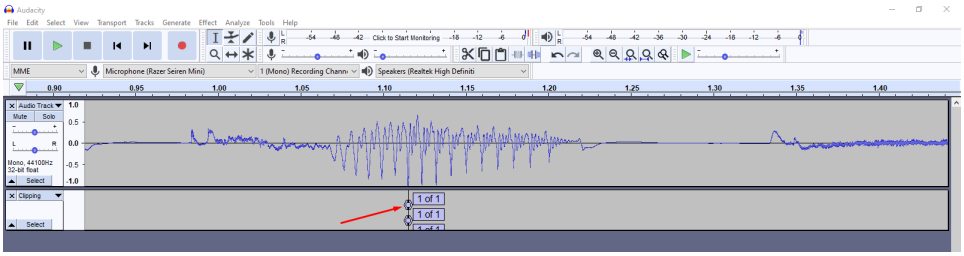


Figure 3.2: Results from the Find Clipping Analysis tool

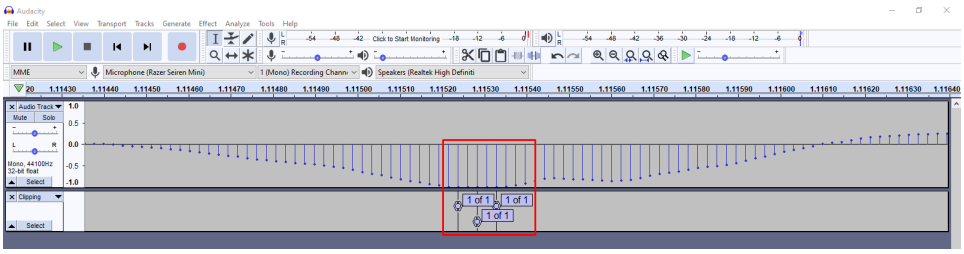


Figure 3.3: Results from the Find Clipping Analysis tool, magnified to the area of clipping

Once the clip location has been identified it is then possible to use the 'Clip Fix' tool on the selected area. To ensure the best results, I selected the section of audio from the 0 signal strength either side of the clip as shown in Figure 3.4.

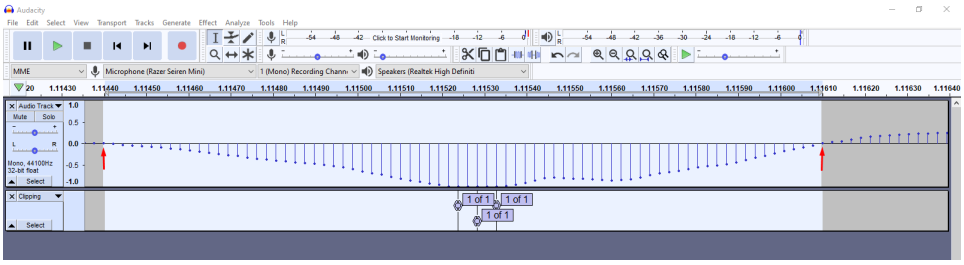


Figure 3.4: My selection around a clipped section to ensure the best results

The result of the clip fix can be seen in Figure 3.5, with the original **clipping** markers for reference. It shows that the area that was clipped has been reduced and that section of the audio has been lowered to facilitate this.

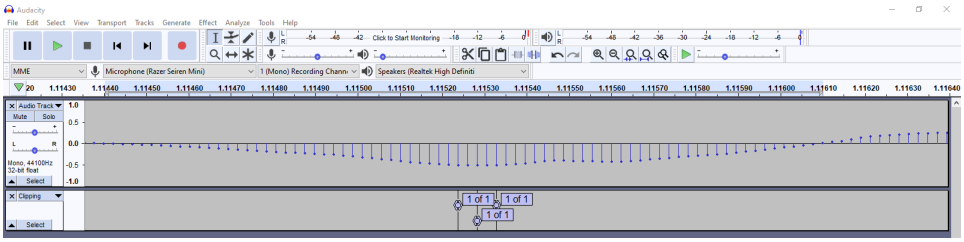


Figure 3.5: The result after the Clip Fix tool has been used, with the original clip location markers for reference

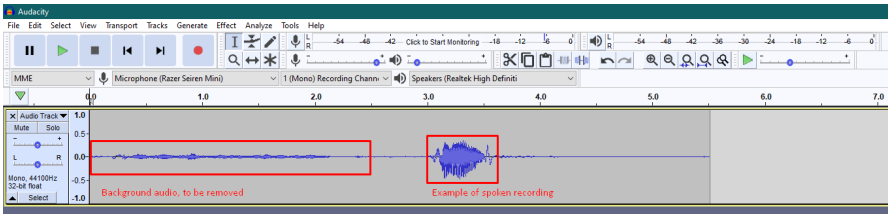
3.3.3 Noise reduction

This tool reduces unnecessary background audio in the track. This will be applied to sections that have a large quantity of background noise. This results in a cleaner audio track without any distractions for the listener.

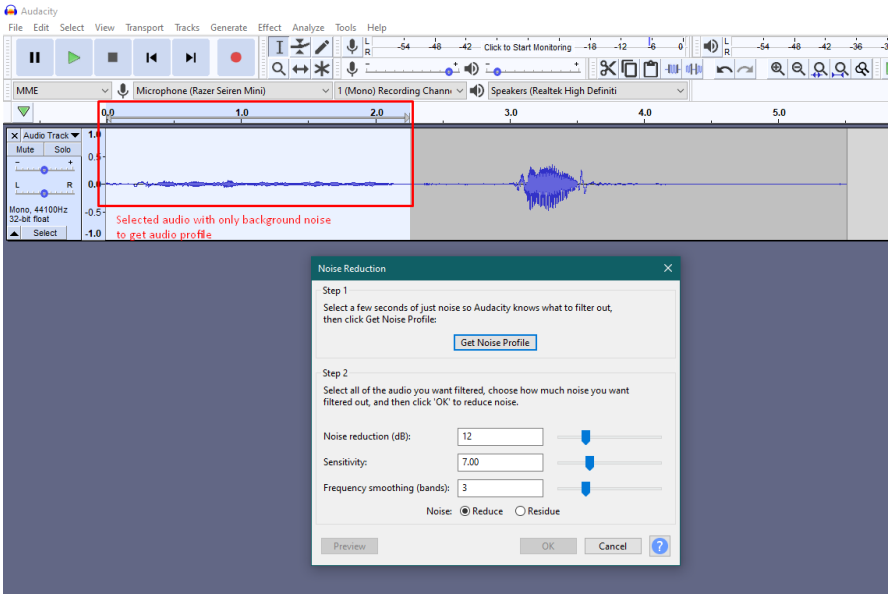
The basic procedure is to identify a single section in the audio track that only contains background audio and for Audacity to use this as an audio profile to remove the background noise [31].

The process for the tool is as follows, illustrated with an example audio track:

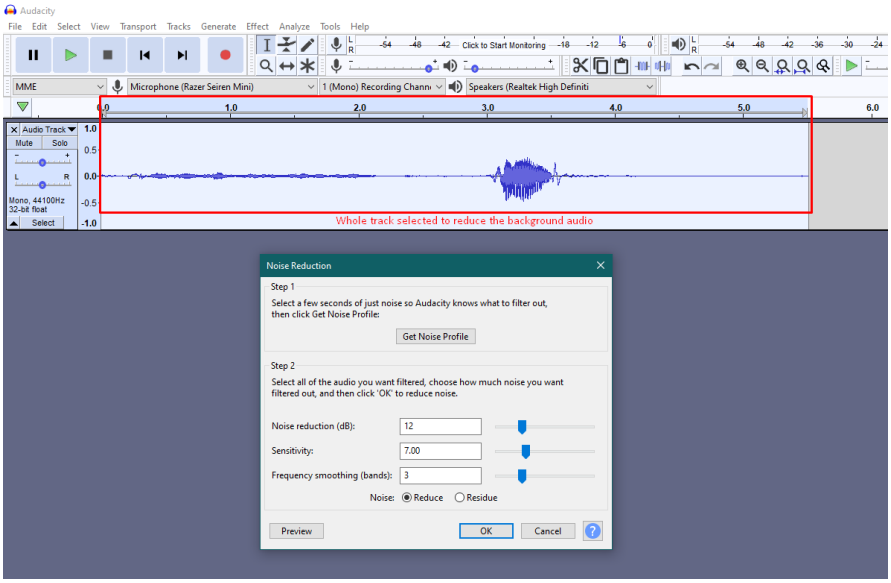
1. Load the track with the background noise



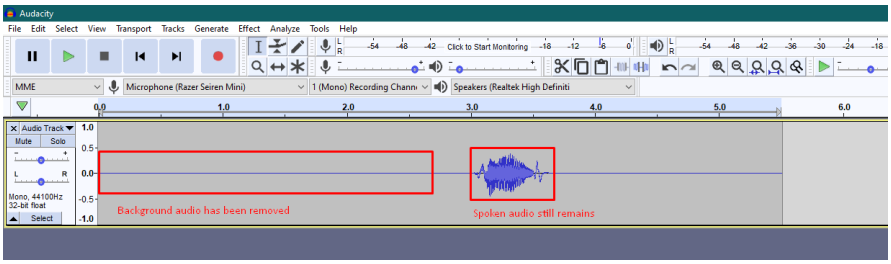
2. Identify a section of the audio that only contains the background noise. This will be used by Audacity to create an **audio profile** for the background noise, which will be used later.



3. A selection of the whole audio track (or the section needed to be cleaned) is selected.



4. This results in a cleaned audio file with reduced background noise.



As shown, this method will only reduce low levels of background audio noise, and not remove it. If there were any loud background **white noise** those would have to be rerecorded and edited in.

3.3.4 Using graphic equalisation to reduce plosives

Plosives are audio artefacts that occur when a speaker pronounces certain air heavy consonants. The air from the consonant strikes the microphone diaphragm and overwhelms the audio recording causing distortion. Plosives usually occur with P, B and F consonants [32].

To reduce plosives, the graphic equalisation tool can be used to flatten out the audio track **frequency** levels, helping to reduce or remove the plosive audio. It is also possible to reduce the frequencies below 160 Hz, however this runs the risk of affecting the audio sound [33] so care must be taken to avoid this.

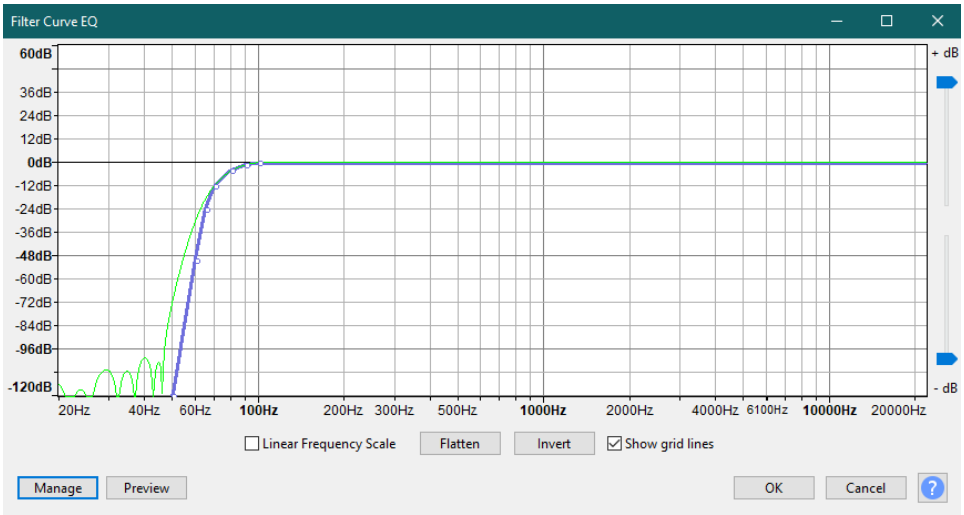


Figure 3.6: The equalisation tool that can be used to remove plosive audios and also remove low frequency rumble.

3.3.5 Volume adjustments

The main goal when editing the audio levels of the track is to ensure that they are at a constant level throughout the audio recording, as this will mean that the listener will not have to constantly change their audio volume settings. Another reason is to ensure the level is loud enough so that the listener does not have to increase their volume settings to a high level.

There are three main methods to adjust the audio volume in a track [34]:

Normalise: This will increase the audio by changing the maximum amplitude of the audio track. This will stop the issue found with the amplify tool.

Compression: This will change the audio volume by increasing the **amplitude** of the quiet sections and decreasing the volume of the loud section to a set amplitude. This will tend to have a net effect of increasing the volume by decreasing the **dynamic range** of the audio track.

Amplify: This will increase the volume of the section by a selected amount. This has a risk of increasing the amplitude above the maximum audio volume possible, thus creating a sound that is beyond the range of the DAW. As such, this should only be used if the editor knows that the volume will not go past the level.

The selected method for my volume adjustment is to compress the audio to reduce the dynamic range, and then normalise it to a max peak of -2dB. This will ensure that the audio is level but also at the correct volume [35]. I did not use the amplify tool as there was no need as the volume increase was used in the normalising step.

I did this step last in my editing so the adjustments to the audio levels were done on the track after previous edits had been completed.

Section 4

Sharing the podcast

4.1 Exporting

Once the editing had been completed and reviewed, I did the final export of the file. Table 4.1 shows the requirements for the file format and **bitrates** for the audio file for it to be approved by the two major distribution platforms, Spotify and iTunes. I chose to export my audio in the .mp3 file format at a bit-rate of 100kbps at 48kHz, which allowed for distribution on both platforms.

Distribution platform	File formats allowed	File bit-rate (kbps)
Spotify [36]	.mp3	96 - 320
iTunes [37]	.mp3 .aac	40 - 80 (at 24 kHz) 64 - 128 (at 48 kHz)

Table 4.1: Table showing the file formats and bit rates for the two major distribution platforms.

I also attached important information in the file's **meta-data** as shown in figure 4.1

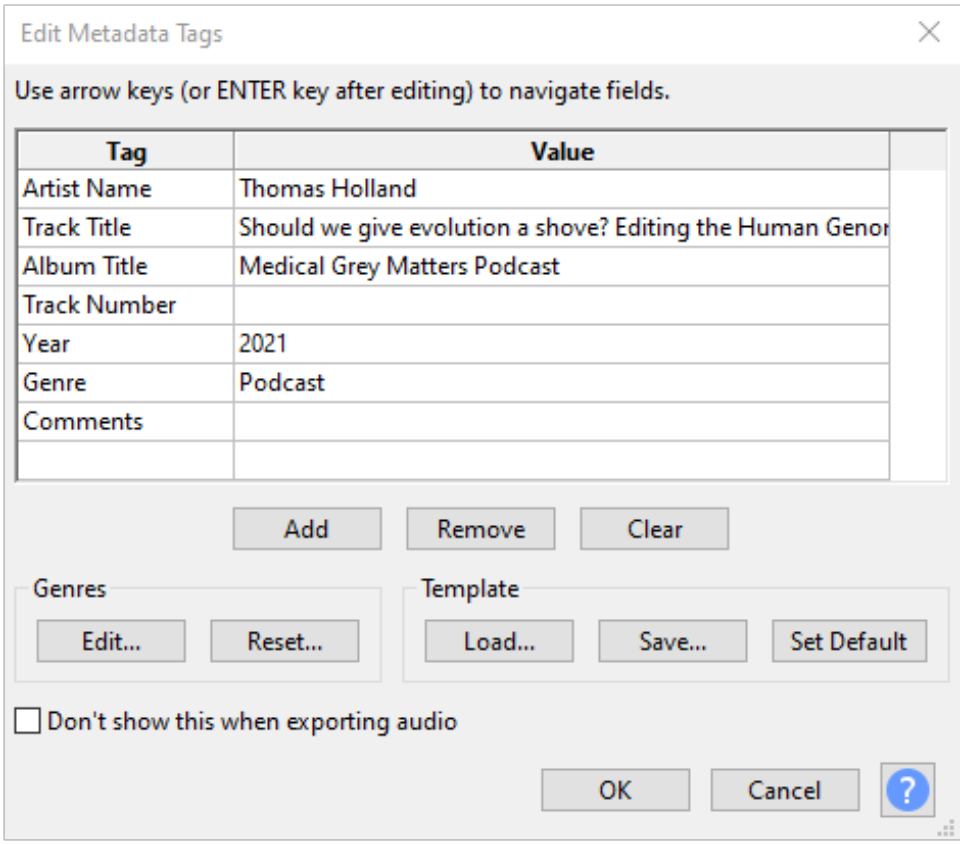


Figure 4.1: Meta-data for the example podcast episode

4.2 Show notes

The show notes are the primary method for the listener to access the sources of referenced information that was used in the episode [38]. As such my aim for the show notes is to provide an easy and accessible option for the listener to find the relevant information from any part of the episode.

The best method that I found was an external site that would be linked from the episode description. This allowed me full control of the layout of the information. I completed the show notes with the following layout:

```
time stamp: source information short name, link
```

This will give the listener an easy index to pinpoint the references they are interested in to help them explore the topics further.

Part II

Products: A podcast through an iterative process

To improve my podcasting skill and to create the best podcast that I could, I did three iterations of my podcast.

The first was a rough prototype, testing the method. From this I changed parts of my method to create the first version of the podcast episode. Using feedback from the first version, I created the final version of the podcast episode, which I again received feedback on.

Section 5

Podcast prototype, a test of the process

This test prototype podcast episode was completed following the method I planned. The episode was never made into a full podcast episode because it was much shorter than both subsequent episodes so that I could have a faster iteration time.

I learnt the following lessons from this prototype episode:

- Although I wished to have a relaxed style, having little content in the script was detrimental as I was unable to focus on my speaking style because I was preoccupied with thinking about what I was going to say next.
- This led to me losing my flow, and thus several confused pauses mid-recording, which would have made the editing of the episode very difficult.
- Also, I found the content to be very disconnected and sections to be unrelated with little flow, and with few interesting points.

From this experience, I made the following changes to the method:

- I changed my scripting style towards a full script. This would allow me to focus on my speaking style without having to memorise the content.
- I tried to only have a single recording for the entire episode, thus making it easier to edit and also more linear and easier for the listener to follow
- I increased the content on He Jiankui, as well as restructuring the order of the speaking points to allow for better content flow. I also put in links between each part of the episode so that each section followed on better.

Section 6

First version of the podcast

6.1 Audio track and contents

I chose the topic area of human genome editing, sparked by the story of He Jiankui [39]. I chose the title: 'Should we give evolution a shove? Editing the human genome'.

Within this podcast I aimed to cover the following questions and topics:

- What is a human genome
- The Human Genome Project and further research
- Who is He Jiankui and what did he do
- The implications of He Jiankui's work
- Wider question of embryonic DNA editing

The content that was included in the podcast (in time order) to cover the topics listed above were:

1. Background on the He Jiankui story
2. The question being asked: 'Should we edit embryonic genomes and to what extent?'
3. An explanation of the human genome
4. Gene inheritance and expression
5. The Human Genome Project and its work
6. How was He Jiankui's work different from other research projects
7. What were He Jiankui's reasons for his research and **intervention**
8. The legality of He Jiankui's actions

9. Research done after He Jiankui's announcement
10. What was the reaction within the scientific community of He Jiankui's work
11. Parallels between He Jiankui's work and other projects such as **mass vaccinations programs**
12. Moral issues about not using the technology that has the potential to cure lives
13. A final discussion on whether embryonic genetic editing will be accepted in the future

6.2 Show notes

For the benefit of access, I have referenced the sources of information and included them in Reference section instead of inputting the links. This is not included in the normal version of the show notes document.

This episode had the following show notes:

0:20 He's announcement [39] [40]

0:23 He's qualifications [41]

0:38 He's gene editing [42]

0:43 He's motives [39]

1:12 Designer baby risk [43]

1:45 Human genome and germ line definitions [44] [45]

1:59 Chromosome structure [46]

2:06 DNA length fact [47] [48]

2:14 Fertilisation fuses parental DNA [49]

2:26 Allele inheritance [50]

2:28 Gene expression [51]

2:33 Inheritance of genetic predispositions to diseases [52]

2:36 Examples of inherited genetic predispositions

- Heart diseases [53]
- Osteoarthritis [54]
- Multiple sclerosis [55]

2:41 Inheritance of resistance to diseases [56]

2:54 Human Genome project [57]

2:56 Funding for the Human Genome Project [58]

3:27 Human Genome Project timeline [59]

3:49 Genome Reference Consortium [60] [61]

4:01 Ethical, Legal and Social Implications program [62]

4:27 Nine different gene editing tools [63]

4:37 CRISPR/Cas9 editing tool [64]

4:39 CRISPR/Cas9 as the 'Science Breakthrough of the Year for 2015' [65]

4:46 He uses CRISPR/Cas9 to edit the DNA for Lulu and Nana [39]

4:55 Use of CRIPSR/Cas9 in papers [66] (this source alone has been itself cited over 10 000 times)

5:06 GM of mosquitoes [67]

5:09 CRISPR/Cas9 to treat humans for HIV [68]

5:16 Experimental treatment of Sickle Cell Disease [69]

5:20 CRISPR/Cas9 to treat genetic blindness [70]

6:26 He's and his teams motives [39]

6:36 Parental HIV conditions leading to low risk of contracting HIV [71]

6:45 He's announcement initially praised [72]

6:53 Confirmation of unethical procedures and forged documents [73]

6:58 He's trial and imprisonment [74] [75]

7:03 He's research papers never published [76]

7:10 Ethical Guiding Principles for Research on Embryonic Stem Cell [77]

7:33 CCR5 edit causing decreased life expectancy [78]

7:53 CCR5 causing change in mental cognisance [79]

8:16 Speculation that He wished to encourage designer babies [80]

8:24 He's research team [39]

8:29 Refusal of He's work [40]

8:41 US National Institute for Health calls for a 5 year ban [81]

9:05 WHO survey [82] [83]

9:45 Dr Helen O'Neill's statement [84]

10:36 Mass immunisation programs wipe out small pox [85]

10:56 Professor Darren Griffin's statement [86]

11:11 Dr Yalda Jamshidi's statement [87]

6.3 Feedback

In order to evaluate my aims, I required several types of feedback on my product including:

- A review and feedback from a person who is familiar with podcasting and has knowledge of Audacity and audio editing. This would primarily be on the style of the podcast as well as the technical level details.
- Review and feedback from a medical professional who is able to provide feedback on the content of the podcast.
- Review from a potential listener to gain feedback on the overall podcast, as well as their engagement because of ease of listening and interest in content.

I also received initial feedback before wider release and so included some additional changes to the podcast before release to the other listeners.

- To include my name and more of an introduction.
- Slow the pace of the podcast down.
- To re-record some of the sections as they were not clear or the diction of a few words were not clear.

From the initial feedback I implemented the following changes before sending the podcast off for further feedback:

- I rerecorded the introduction, including my name.
- I rerecorded sections that were difficult to hear and significantly impeded the listening.
- I changed the tempo of the whole audio track, aiming to make it easier to listen to.

6.3.1 Feedback from a podcast specialist

Mr Pearson is a Physics Teacher at the King's School Worcester. Currently he is also managing the school's radio station 'The King's Voice' and helps students in the production of their own shows. Mr Pearson has a very great understanding of the podcast creation process as well as audio editing, with previous experience in DJing and radio. Mr Pearson also has an in-depth understanding of Audacity, having used it previously.

The feedback I received was:

'I really like it - it's very informative and you come across passionately about your subject - well done. I like the grey (mixture of black and white) title too.

It is very heavy (lots of info in a small space of time) - but it has to be as the EPQ needs to show depth of knowledge so there's no easy way round that.

Two (small) things to improve on. I feel you get more into it as you go through, and more passionate. Start the podcast with more enthusiasm - make the listener want to continue listening. Maybe quickly say what you're going to be discussing and say something like "you will find this out during today's podcast". This will make it sound more like a podcast, and less like you're recording a reading of what you've written. Imagine you're presenting a TV show - it's a TV show without the screen basically.

Also, I'd finish the podcast by saying something like "tune in next time where I'll be discussing..." etc.'

6.3.2 Feedback from a medical professional

Dr Ian Whitcroft is a consultant dermatologist, specialising in skin cancer and has done research in modern treatment options [88]. His comments were:

- The podcast was very good and raises some interesting medical questions.
- The podcast touched upon the secondary interactions that genes have with each other, and the non-binary affect they have, as this is a topic that science has still to fully understand. It might have been beneficial to state this explicitly and give more details about the theory.
- The podcast looked at the 'butterfly effect' that the gene editing in embryos will have on future generations, as this is one of the major ethical implications of embryonic gene editing. It might have been beneficial to explain and explore this further.
- Maybe it would be good to mention about who makes the decisions on the gene editing, and on what, as judges, politicians and the medical governing bodies (especially the World Health Organisation) may have differing opinions to doctors and the other medical professionals. Dr Whitcroft's view is that no-one should be allowed to 'play God'.
- It is important to mention that many in the scientific field believe that there has not been enough research done into the complexities of gene interactions and so this gene-editing 'intervention' was done too early.

6.3.3 Feedback from listeners

Feedback about the podcast concept or scientific content

- A listener mentioned that even as a non-medical person they found it 'easy enough to understand even though it covered complex concepts' and others said the scientific content was easy to follow.
- Some listeners said they were interested in the podcast and it was educational.
- Some listeners said that the science sounded well researched.
- Some listeners commented that they enjoyed the concept of the 'grey matters' as it allows the listener to 'form their own opinion' and so a 'relationship with the listener'.
- One listener mentioned that they knew from the beginning what they were going to get from the summary.
- Some mentioned that they think it would suit a wide demographic as it is not too complicated but also not over simplified.

Feedback about the podcast style or technical aspects

- Some listeners said that they heard some odd pacing in the episode at a few points.
- Some listeners commented on how some of the audio splicing (editing) 'didn't sound very clean'.
- Some liked the structure as it was a logical progression through the episode.

Feedback about their personal response to the podcast

- It made some listeners think about the implications of gene editing
- It made some listeners think of the impacts this would have on the twin girls
- It made some listeners debate and reconsider their views whether gene editing on embryos should be used.
- It made some listeners interested to listen to another episode.
- Some were interested as this was 'super niche but they enjoyed the specific content'.

Section 7

Final version of the podcast

7.1 Changes to the method as a result of the feedback

7.1.1 Feedback analysis

From the feedback I received, I learnt several useful lessons that I used to change my method for the final podcast. These learning points were that:

- I had sacrificed the podcast feel and style for the content, which was something that I had aimed to avoid
- The timing needed working on as there were unnatural gaps and pauses. This, occasionally combined with two words that sounded like one, made for a difficult listening experience and difficult to follow.
- The podcast was information dense, and with few pauses, which made the podcast hard for the listener to digest.
- There were some simple tricks that were highlighted by the Podcast Specialist, and with implementation of these, I would be able to both increase the podcast feel as well as provide light gaps that would lead to higher listener retention time.
- There were some areas of the topic that I could have explored in more detail, providing interest for a more advanced listener base. Although some points raised by the Medical Professional were personal opinions, others were areas that were important to debate to bring more balance, depth and different perspectives to the discussion.
- It was mentioned by listeners that the content was easy to follow, and so I think this was important to maintain, even with the addition of new content or a change in style.

- Even though one listener said that they knew what the podcast content would cover from the introduction section, as the Podcast Specialist suggested, I believe it would have been better to have a high level summary that would state this more clearly and have opening questions to engage the listener.

7.1.2 Changes made to the method

From the feedback received as well as from the personal experience gained from making the previous podcast episode, I made the follow changes to the method:

- Added in questions and an overview at the beginning of the podcast episode.
- I extended the final outro segment, to include both a 'next time' and a 'here's a thought' message.
- Added in some additional explanations and extended points to introduce more balance and depth.
- After I created the script, I identified areas that I could introduce more personalised aspects to allow for a more relaxed and personal podcast.

7.2 Show notes

0:40 He's announcement [39] [40]

0:44 He's qualifications [41]

0:52 He's gene editing [42]

1:04 He's motives [39]

1:12 He at International Summit on Human Genome Editing

1:35 Designer baby risk [43]

1:58 Human genome and germ line definitions [44] [45]

2:22 Chromosome structure [46]

2:31 DNA/Chromosome length fact [47] [48]

2:46 Fertilisation fuses parental DNA [49]

2:53 Allele inheritance [50]

2:56 Gene expression [51]

3:06 Inheritance of genetic predispositions to diseases [52]

3:10 Examples of inherited genetic predispositions

- Heart diseases [53]
- Osteoarthritis [54]
- Multiple sclerosis [55]

3:22 Inheritance of resistance to diseases [56]

3:31 Evolution by Natural Selection [89]

3:42 Modern medicine slowing evolution and natural selection [90]

4:12 Human Genome project [57]

4:21 Human Genome Project timeline [59]

4:35 Funding for the Human Genome Project [58]

5:08 Genome Reference Consortium [60] [61]

5:29 Ethical, Legal and Social Implications program [62]

5:54 Nine different gene editing tools [63]

6:05 CRISPR/Cas9 editing tool [64]

6:05 CRISPR/Cas9 as the 'Science Breakthrough of the Year for 2015' [65]

6:17 He uses CRISPR/Cas9 to edit the DNA for Lulu and Nana [39]

6:21 Use of CRIPSR/Cas9 in papers [66] (this source alone has been itself cited over 10 000 times)

6:29 Genetic modification of mosquitoes [67]

6:34 CRISPR/Cas9 to treat humans for HIV [68]

6:42 Experimental treatment of Sickle Cell Disease [69]

6:47 CRISPR/Cas9 to treat genetic blindness [70]

7:56 He's and his teams motives [39]

8:12 Parental HIV conditions leading to low risk of contracting HIV [71]

8:24 He's announcement initially praised [72]

8:34 Confirmation of unethical procedures and forged documents [73]

8:38 He's trial and imprisonment [74] [75]

8:42 He's research papers never published [76]

8:58 Ethical Guiding Principles for Research on Embryonic Stem Cell [77]

9:26 CCR5 edit causing decreased life expectancy [78]

10:15 CCR5 causing change in mental cognisance [79]

10:36 Gene interactions are more complicated than binary interactions [91]

10:54 Speculation that He wished to encourage designer babies [80]

11:02 He's research team [39]

11:05 Refusal of He's work [40]

11:25 US National Institute for Health calls for a 5 year ban [81]

11:47 WHO survey [82] [83]

12:31 Dr Helen O'Neill's statement [84]

13:22 Mass immunisation programs wipe out small pox [85]

13:42 Professor Darren Griffin's statement [86]

13:57 Dr Yalda Jamshidi's statement [87]

14:17 Nuffield Council on Bioethics research [92]

15:46 Professor Lovell-Badge's statement [93]

7.3 Feedback

The feedback received on the final version of the podcast was less in depth as it was confirmation that the changes to the revised method had resulted in significant improvements.

The feedback received from the Podcast Specialist, Mr Pearson, stated that:

> 'I have just listened and it's much better! You sound really passionate and interesting. I like the intro and the fact you've advertised next week. It's brilliant, well done!'

The feedback received from the Medical Professional, stated that:

- It was much more enjoyable and interesting overall, and easier to listen to.
- It was good to hear the additional details as it added balance from a medical perspective.

The feedback I received from the listeners was that:

- The production quality was more professional.
- The presenting style was more enthusiastic.
- The listeners enjoyed the questions as an introduction and found it made them intrigued and compelled them to listen on.

- The sound quality was superior to the first episode.
- The summary was more in-depth and provided a more thought provoking conclusion to the episode.
- The podcast felt less rushed and slower, and also that there were less timing and phrasing issues, with either too long or too short gaps between words, which helped them better follow the episode.

Part III

Conclusion

Section 8

Reflections on the final product and changes to the method

Because of this project, I have definitely developed my personal podcasting ability. This was largely aided through the wealth of resources that are available online and, more importantly, the feedback given by the Podcast Specialist, the Medical Professional and the listeners. The changes I made to my method, because of the feedback I received, meant I accomplished my goals.

I learnt that this process of iterative creation allows for the best usage of resources, both time and energy, and so ends with the best product fastest. This core concept allowed me to quickly identify the areas that needed improvement and implement these changes.

Another important lesson with the creation of the podcast was how to use the creativity needed for this style of product. I found it more important to focus on the editing areas that had the most impact, such as the equalisation and the mixing, rather than editing out every small noise. This allowed me to have a more holistic view of the podcast, make it feel and sound more natural, and in the end create a more professional product. It was surprising how reducing the number of minor edits had the effect of a more polished product, showing that with editing I had found the optimal point at which more work would actually be detrimental.

The most important change that I made during the creation of the final podcast version, was during the recording when I actively slowed down my pace. This had the primary effect of making the audio more digestible and easy to follow, but also the secondary impact of allowing more of my personal style and speaking inflections to show through, as I was less focused on getting through the content. Another benefit of slowing the recording was it allowed more natural breaks between the content which made the editing

easier to manage as I did not have to reintroduce these gaps. This was highlighted in the feedback of the first version to be a hit and miss exercise, with improvement noticed in the final version.

By opening with the three questions that summarised the podcast, I learnt it really helped me focus in on what the important messages of the podcast were. This meant that the listeners firstly knew what to expect and secondly were able to form ideas in their mind during the rest of the introduction so they became more actively engaged in the podcast debate.

One of the most important aspects that I had to balance throughout the project was the fine line between content that was enjoyable for a listener with little technical background or understanding of the topic area and content that was engaging and stimulating for the listeners who would be interested in a science heavy podcast. This was very hard as normally those would be two separate niches that would require two podcasts. I think that I found this balance through using technical terms and concepts, but either in non-expert language or explaining what the terminology was. Also, starting with a basic foundation, building upon topics typically learnt at GCSE/A Level standard, and then taking it to a higher level with explanation, allowed for all to be involved. I think also that the concept of debate is one that every person has the ability to do, and when it comes to medical healthcare and moral ethics, most people will have an opinion for discussion.

One of the hardest areas that I found when creating this podcast was in episode conceptualisation. I found it difficult to follow the planned method as I initially got overwhelmed with the vast array of possible topics, unable to find a link between any of them that would make into a good podcast episode. When in the conceptualisation process, I found that having such ease of access to these sources made it easy to get distracted by a new source, thinking that this new topic would be better material for a podcast. In order to be able to conceptualise a podcast, I decided to change my method by picking a topic that has recent relevance but also of personal interest. Then I proceeded to find material and references around that central idea to make the podcast concept.

Throughout both iterations, I found that progressively the recording of the episodes got significantly easier. Because of the steps changed in the method, as well as the increased experience of listening back and editing the audio, I was able to understand and match my technique to the podcast audio quality. This also meant that in the final podcast episode I was able to have a consistent sound throughout the podcast.

Section 9

Reflection on aims and goals

My main goal for this project was to create a well researched and interesting podcast that gets positive feedback response from listeners. With this in mind, I designed a process that would enable me to collect feedback responses through the different stages of the project. At every stage I received different levels of feedback, with the final version of the podcast receiving the most positive feedback.

During this project I wanted to develop my personal abilities and skills. The first area that I wished to improve my skills in were researching and presenting arguments for debate. From the feedback given, I accomplished this goal in both versions of the podcast I created, however, it was clear that I have improved from the first version to the final, if only by changing the style so that the discussion was better received.

Central to my podcasting development was the expanding of my speaking skills. Initially I struggled with this area in my first prototype as I had little experience recording myself and speaking in a way that recorded well. With experience of both podcasts, I improved, feeling more comfortable to express myself in front of a microphone.

My editing of the podcasts was an area that I had to develop the greatest, as my initial edits for the first podcast were focusing on the wrong areas and did not have a positive impact on the podcast. However, once I simplified my strategy and focused on high yield areas that were important to perfect I created a podcast that in my opinion, as well as from people that gave me feedback, had improved. The edits that I made in the final podcast were less noticeable, in particular the splicing of several sections, were more natural sounding and maintained a natural flow.

One area that I identified at the conceptualisation of this project was the dichotomy of a podcast on scientific content. Podcasting is a very personal, relaxed and intimate medium, and this contrasts with the scientific content which needs to be fact driven, with little personal interpretation and associated with the more formal, lecture-style delivery. This was interesting

for me to explore, and I think that by the final podcast episode I was able to find the correct balance between the two. I used the style of the podcast to display my personality and emotion, especially with my speaking style, without stating personal views or introducing any bias.

I thoroughly enjoyed researching the comments and reactions of a diverse range of experts in the field, and then using their statements and opinions to build a picture for the listener to decide.

From the feedback I received, I am able to say that I have created an interesting and stimulating podcast that has acted as a medium for unbiased debate of medically relevant ethical topics. I was pleased with the positive reaction to the show notes, and that they effectively provided the listeners with a starting point for further research. Collating the show notes also made me realise how important detailed research is to both the breadth and the credibility of the content.

Finally, I am happy that Mr Pearson is going to publish my podcast on 'The King's Voice', the school radio station, and this is real affirmation that my goal has been successfully achieved.

Section 10

Reference validation

For this project, the two primary uses of the sources were for the dissertation and for my show notes that I use for my podcast. This gives rise to two different styles of sources. As such, there will be a section discussing my validation of both.

10.1 Sources for the Podcast

Both my personal and general aims require well-researched and validated sources to present the information to the listener of the podcast. As such, the validation of the information that I found was paramount for the success of this project, and so I gave myself a few guidelines to follow when researching the topics for my podcast to ensure that the quality and validity of sources are of high calibre.

- Check the number of citations that the material has in other academic works, the higher the better
- Aim to use the most recent information possible, unless showing how ideas, concepts or laws have changed through time
- To validate the author of the referenced work as credible
- To ensure there are no conflicts on interest about the source, either noted or later discussed
- To check for any suggestion of opinion or inference rather than factual information
- Te check the sources of information that the authors reference, to ensure that there has not been any misinterpretation, either deliberate or accidentally.

By choosing to use notable journals and publications, I have ensured that the above conditions are met, and so most of my sources for information is substantiated and justifiable. However, if this was not possible to validate the information source I would decide on the importance of the information. If I still wished to use it, I would add a caveat in the podcast and the show notes.

Although this increased the time taken to create the podcast, I felt this was paramount to ensure the quality of the podcast is high and that it was a credible and reliable information source

An example of this is the original YouTube video that He Jiankui released [39]. Although this would give, understandably, a very single sided view of the topic, I felt it was important to include this in the podcast as it allows He to justify himself, explain his reasoning and to provide a balancing point of view. To ensure that this had not been changed since release I used the Internet Archive's Wayback Machine to ensure that the original content was not changed or removed. As well as this, I used other sources of information to validate any scientific claims that He made during the video that I would be using.

Another example of my validation was when I ensured that an article from the Science Magazine [73], was correct. Firstly, I searched for the number of papers that had subsequently cited this source, which was 13. I also researched the author of the work, Dennis Normile, as well as the aid in reporting, Jon Cohen, and at the time there was no suggestion of any misinformation and they had both published several articles with reputable publishers. I also checked the several people that they had quoted, such as Robin Lovell-Badge of the Francis Crick Institute, and again no red flags were raised.

10.2 Sources for the Dissertation

Because there are limited academic resources that would aid me in the development of my podcast, combined with the changing podcast landscape, I decided to allow myself to be less stringent with my method of source validation. Instead, I took validation from the reputation of the author, their podcasting and presenting works as well as verifying the information against other sources, ensuring that I was forming a robust view and thus making valid decisions based on this information. Because I could identify no reasons or evidence for conflicts within my source pool for my dissertation this was not a concern.

Most of the sources I have referenced were written recently, within the last year, and as such will maintain their relevance during the time frame of my project. As the podcast industry is fast moving, new platforms and tools may be released and as such the information provided and recommended may

change. However, the basic concepts and methodology, and the principles of the project, should remain correct. Also, since Audacity was originally released in 2000, and the most recent update was in January 2021, there is a strong probability that Audacity will remain a tool with longevity.

The majority of the authors of the sources that I have referenced have created their own podcasts or are leaders in the field, and as such I am confident in referencing their works.

Part IV

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