Department of Electronic Engineering

MSc in Audio and Music Technology Project Report 2020/2021

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The Creation of a Syllabus: Developing an International Baccalaureate Course for 'Music Technology'

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Abstract

Level-3 Qualifications, typically taken between ages 15-18, are designed to be the final level of schooling before access to higher education. This report looks into existing research surrounding Level-3 Qualifications within the subject of 'Music Technology'. It aims to outline the parameters which would comprise a 'Music Technology' course and assess the current situation regarding pedagogy and the different approaches in this field. The report makes links the practices in a 'Music Technology' field to international education standards such as the 'International Baccalaureate (IB). This is to argue why it should be included as an option in the curriculum. The report is given from the viewpoint of an individual who studied under the IB curriculum but was not able to study this subject at a Level-3 standard. The report explores what 'Music Technology' really is, what Pedagogy is, and how it relates to 'Music Technology', and offers an overview of the IB and how its core structures can be linked to practices in 'Music Technology'. The overarching goal of this report is to give evidence to the argument that 'Music Technology' should be offered at IB level, and suggest a syllabus to be adopted by the IB.

Contents

Chapter 1

Introduction

Music Technology is an industry that spans multiple generations and has endured a lot of change. Initially, from engineers with science equipment to creative professionals today with nothing more than a laptop, the formal education of these positions is an important part of the regulation of the industry. Usually, through working one's way up the ladder from runner to studio hand to recording engineer, the aspect of shadowing and being integrated into the music recording process can not be understated. The simple act of being a 'fly on the wall' and observing the actions taken are important to immersing ones self in the creation process. With the modern age of technology capable of real-time playback and manipulation of multi-track audio, the barrier for entry, usually hidden behind purpose-built studios with million-dollar recording consoles, has all but faded. The accessibility of software and hardware could be argued to make the industry dubious about taking on 'bedroom producers' or someone who has only perused Music Technology through laptop production. Thus, a formalised education in Music Technology often shows that the skills required to be in a studio environment have been met. Level-3 Qualifications such as the A-Levels and the International Baccalaureate (IB) are an important step as they allow for specialisation at a far greater level than GCSEs or secondary education. However, the IB does not offer a formal education specialising in the area of 'Music Technology'. Throughout this document, the reasons why a formal education of this subject should be considered by the International Baccalaureate and how the syllabus may look. Additional teaching tasks have been provided which demonstrate exactly how teaching may take place within a module. The approach to the creation of a new syllabus will be based upon the previous syllabi designed and published by the IB.

1.1 Aims and Objectives

Aim: Develop a syllabus for the subject of Music Technology, utilising the format and key concepts of the International Baccalaureate.

- IB
  - Evaluate the similarities and differences between international qualifications
  - Evaluate the key concepts of the IB and observe how the skills of 'Music Technology' relate
  - Evaluate and replicate the style and context of IB subject guides/briefs
- Pedagogy

  - Evaluate how hardware and hands on control enhance the overall attachment and engagement of a subject
  - Evaluate the role of creating ones own technology and how the creativity and problem solving can enhance learning and retention
  - Find a balance between the role of the teacher and independent study
- Subject
  - Develop/Research a robust definition for the subject of 'Music Technology'
  - Create 2-3 lesson plans ready to be deployed
  - Evaluate the skills required for 'Music Technology' and develop a hierarchy for prioritisation

The evaluation of similarities and differences in international qualifications allows the opinions and current state of education to be analysed from multiple points of view. This makes for a more diverse and encompassing outlook on the creation of a course. Looking at the key concepts of the IB will allow the course created to align with the styles and systems which the IB promotes. This will make the overall style of the document more believable and more likely to be approved. Replicating the style of the IB guide will allow the physical appearance and the organisation to remain the same across all IB guides, including the one created during this project. This will further allow the guide to sit into the roster easier than if it were created alone.

Looking at hardware and hands-on control will allow the author to see whether a traditional studio module, with an analogue desk, is required for learning the concepts of signal flow. This will inform the style of the module and whether or not it can be done remotely or purely digitally. The role of creating ones own technology is an important factor as it will inform the use of programming projects. It will evaluate whether programming projects are worth perusing, changing the content and teaching styles in the process. The IB puts a significant emphasis on independent learning, researching the role of a teacher and the balance which they impose is crucial to the structure of the course.

Developing a robust definition for the subject of 'Music Technology' is perhaps the most important objective, as it will steer the content and subsequently the techniques of the course. A definition allows for the boundaries to be set by what is taught, this will allow the course to create its primary form. 2-3 lesson plans will allow the author to pitch their course as if it was being taught, this will give a sense of the techniques and content put into practice. Looking at the skills required for a music technology practitioner will allow the content of the course to reflect what a practitioner would use in multiple industries. This will be reflected in the final course content as with limited time there are only a few areas that can be focused on.

Chapter 2

Background

2.1 Music Technology

'Music Technology' as it is commonly referred to, describes the practice of using technology in a context related to a musical application. This could include the tools in which a musician could use to perform, learn, or analyse. Usually linked to the creation of music using a computer and other technologies, music technology extends far beyond its conventional applications. Looking at creating a definition for music technology can help when applying its content to teaching.

2.1.1 Define Music Technology

When looking through literature, it is easy to assume that a subject presented occurred naturally, or was there simply before our time. But the definition of a subject is much like the genres of music, which could be based on specific characteristics, such as 'house' music and its sub-genres. Alternatively, it could be labelled based on its application, such as 'rave' music. Although often there is an overlap in definitions, we allow leeway to expand or refine our definitions. 'Music Technology' is a term which becomes clouded when looking at applications and characteristics, as it is often used as an umbrella term for many job titles and applications. It is thought that due to its multidisciplinary nature, the subject definition relies on context to define the roles of someone who studies music technology [1]. It is suggested that to create a definition of music technology, it is important to break down that word into its constituent parts [2].

> "Music is the world of sound and silence that is manipulated by different compositional, improvisational and instrumental means." [2]

This definition explains that the simple act of manipulating sound can be defined as musical. By this means, methods which simply shape music or interact with music could be argued to be musical, such as the methods that audio engineers engage with. The next definition is 'Technology'. It is suggested that:

> "*techno* refers to an art or craft while *-logy* refers to the study of a field"[2]

This means that the term 'Music Technology' could be seen as the *study of the art of music*, however, the Greek word of which 'technology' is derived, *'technologia'*, refers to a

systematic treatment of the subject. Through this lens, a definition of 'Music Technology' could be *"The systematic study of musical tools and techniques"*[2].

It is important to evaluate the use of Technology throughout our history. Technology in our modern definition is often associated with digital or scientific practices, however, technology was simply the mechanics of getting things to work. For recording engineers during the late 19th century, wax cylinders were the height of technology [3], this mirrors what we are experiencing at the moment with a revolution in Artificial Intelligence. This means that a definition of music technology should not be linked to any current or past technology, and similarly, should not be linked to any current trend or cultural significance. Thus, a proposed definition fitting all these rules might be:

> "the systematic study of tools and techniques for music production, performance, education and research"[2].

It is also important to analyse exactly what a 'Music Technologist' does in order to find where jobs fit into what Boehm describes as the 'Triad of Music Technology'[1]. Here she identifies the three components which constitutes a potential in music technology: art, technology and science. 'art' refers to the creative portion of music technology, where music composition and creation of electro-acoustic and sound design material is found. This is often linked to the phrase 'creative music technology'[4]. Next 'technology' refers to the section connected with sound engineering and recording, this produces job titles such as 'sound engineer' and 'recording engineer'. Finally, the 'science' aspect links itself with the wider topics of engineering, software and hardware research and development.

This idea of the three sections of 'Music Technology' could not reflect the current market, where a fourth approach has developed due to the increase in accessibility in the subject. 'Production' is an argued fourth point to the 'Triad of Music Technology' involving the artistic direction of a record, musical performance and arrangement and the freelance market[4]. With this addition, the new 'Tetrad of Music Technology' was created [4].

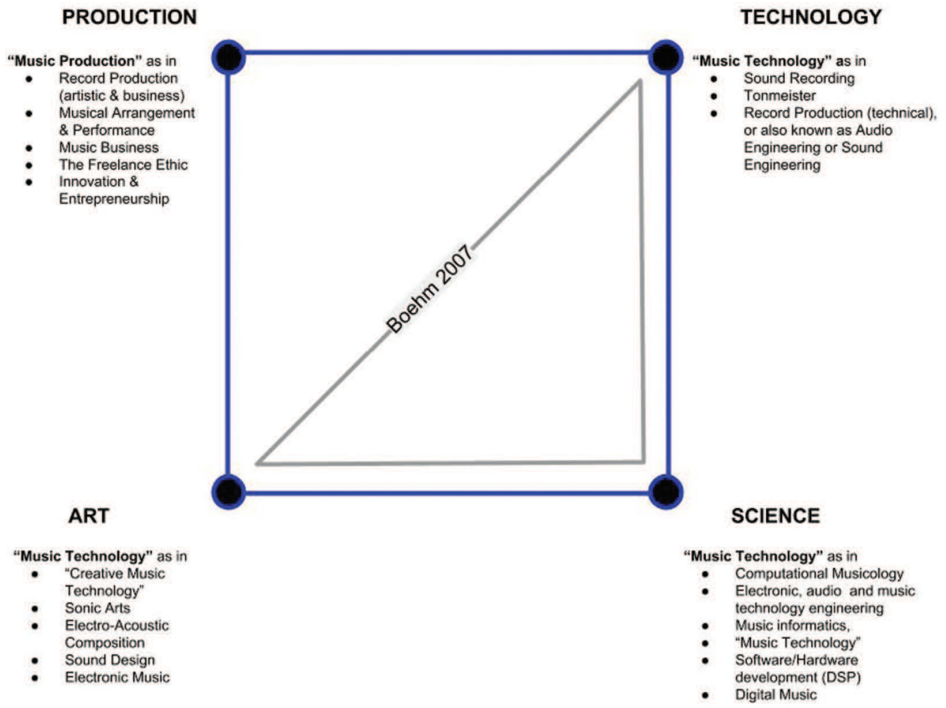

Figure 2.1: The Tetrad of Music Technology compared to the Triad of Music Technology [4]

2.1.2 The 'Four' pillars of Music Technology

With four pillars of 'Music Technology', it is important to know exactly what content fits into each corner. This definition allows people to specialise and dig deeper into their given skills.

For a technology-based music technology practitioner, one would require a highly trained ear and deep understanding of signal flow within a recording console. one would also require the skills to conduct a recording session under time and financial pressures. This would entail communication and decision-making regarding if a recording requires another take or if the artist needs monitors. For a science-based music technology practitioner, the requirement is a great understanding of the physics and electronics behind the equipment which someone would use to record. This usually entails education to a degree level and a comprehension of technical literature relating to the product in use (circuit diagrams, source-code, etc). For an art based music technology practitioner, working as a composer to create pieces of music which typically include an element of electro-acoustic, requires knowledge of the elements of music and an in depth understanding into compositional styles and requirements. Finally, a production music technology practitioner would be engaged with the freelance market renting and recording in studios, in addition to acting in a performance role when required. This requires skills from each strain but does not specialise in any one point of the tetrad.

The reason why this is important and connected to the IB adopting a course is that a definition gives guidelines as to what can and should be included within a given context. In this case, it is paramount that what is proposed is relevant and practical to teach both in content and concepts.

2.1.3 What should be taught?

The argument as to what should be included in a syllabus and what should be taught is a difficult question to answer. Taking a baseline of Boehm's 'Tetrad of Music Technology' [4] allows us to distribute time and focus. Due to the nature of the Level-3 qualification leading into industry or higher education, there is not enough time to specialise this early. Thus, time should be split equally between the four different areas.

Coding as a means of learning

The act of programming allows students to extend past the physical applications of software and engage with the concepts of sound on a deeper level[5]. Coding has been incorporated into many studio-based courses as it allows the creation of custom tools. As mentioned, PD is one of these programs.

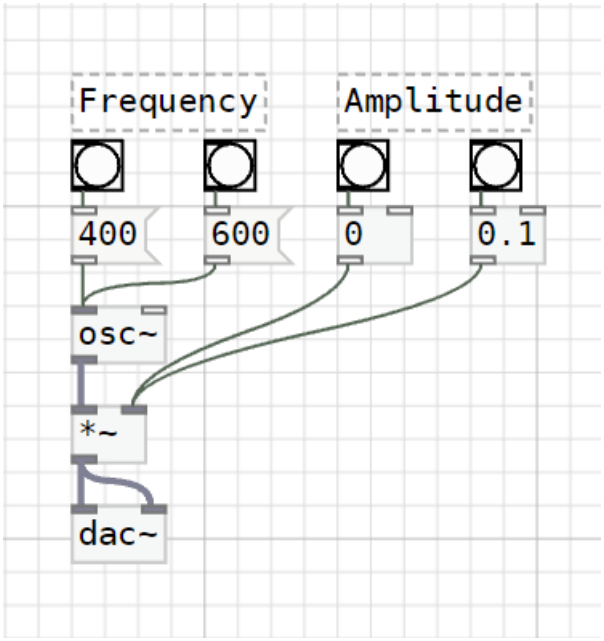

Figure 2.2: An example of Pure Data being used with buttons to change the frequency of a sine wave.

The advantage of using PD is that having "the ability to design specific compositional processes and add explicit user control creates a firmer bond between understanding and experience."[6]

Potential applications for this include: creating synthesisers, to understand the principles of sound design; creating sequencers, to understand the principles of MIDI; creating both temporal and frequency-based effects, as a means to understand Digital Signal Processing (DSP); and possibly creating custom tools to conduct perception testing to help explain and understand the human ear.

Live electronic music can be different from acoustical music, as the interaction with sound becomes detached. Pressing a piano key down to create mechanical leverage to strike a string is very different from a contact pad conducting a signal. The ability for

sound such as a sampled piano to be triggered with an Electric Wind Instrument (EWI) makes the distinction between mechanical and electrical irrelevant.

> "The boundaries between composer, improviser, performer, technician and instrument builder have been blurred, and performing has in fact become an inadequate term."[7]

The teaching methodologies surrounding programming languages and user software in the case of music technology allow for theory and practice to become the same. Being able to see how a musical effect is working allows a deeper understanding of theoretical concepts such as buffers in the case of delays.

> "A user can not only play with a delay effect, but he can also see how the delay effect was built. This kind of transparency helps a tutor to deal with theoretical knowledge within a performance context and corresponds very well to the action-based philosophy of live electronics courses."[7]

This presents problems for teaching with open-source software at a young age. The first comes from The Paradox of Choice, where a student would become paralysed as they are given such a large and confusing range of possibilities. This could lead them to lose motivation. There is also the ability for open-source software to be difficult to learn, as it requires more technical knowledge from the user than typical commercial software. Finally, the depth which is required to start performing and composing is so deep that it may be impractical to cover as it would take too long to learn. There is simply too much syntax and basic units to teach before progressing to build an instrument [7].

Another problem comes in the form of focus. A course about music technology would not typically inspire thoughts of coding, thus a student would have different motivational goals than computer science students [5]. With approaches to programming, music technology students would be more inclined to expect a creative and musical focus than a computer science course.

Teaching can come from two approaches: graphical or text based. The previously mentioned PD allows the use of objects and patch cords, mimicking the act of patching in the studio. Allowing one block to connect to another sequentially allows the visualisation of the flow of data. As a stark comparison, text-based can often offer more flexibility and a deeper understanding of text-based protocols such as MIDI. Although both can achieve the same goal, it is important to teach both, as they will allow different students to take to whatever approach they better connect with. In addition to this, both approaches offer different opportunities in professional development[5].

A pedagogical technique for programming is what is known as 'Pair Programming' where the task is completed not as a solitary endeavour but as a pair of students working together. The concept is that one person 'drives' and types the code, while the other 'navigator/observer' reviews the code and offers constructive direction. These roles switch frequently to avoid one person conducting all the 'driving'. This feeds into 'Laptop Ensembles' such as the Stanford Laptop Ensemble's performance of Twilight in 2013:

Figure 2.3: The performance, where each student gets to determine how they best contribute to the group and what skills they are able to develop. [8]

> "Students can also have a hand in determining for themselves how the different possible roles could be divided up and tackled: performer, improviser, conductor, composer and even software/instrument designers. Each of these roles comes with its own set of skills, both musical and transferable."[9]

Another language which offers similar simplicity to PD is SuperCollider (SC). SC is a programming language written in C++ utilising unit generators (UGens) to create highly complex synthesis systems with a very small amount of code. Using such a programming language introduces the student to text-based programming and allows for creativity in a flexible manner.

```
{SinOsc.ar(MouseX.kr(400,800))*0.1}.play
```

Figure 2.4: This code allows a student to control the frequency of a Sine Oscillator with their MouseX position from 400Hz to 800Hz. [10]

This can be expanded with the addition of lists and MIDI I/O, it allows the ability to create generative music. Generative Music is created using algorithms and random values, a process which is very easy to achieve when a student is coding the algorithms themselves.

Coding plays such a large role in the current market with more and more people choosing to mix on a computer also known as 'In the Box'. Learning how to create the tools which these mix engineers use is a great method to understand concepts and give a foothold in the industry. Incorporating coding into the study of 'Music Technology' allows more opportunities and more transferable skills.

The argument for Open Source

The use of Open-Source products presents an opportunity in teaching object-based coding projects. Object based describes using pre-built functions provided by the language. Using PureData (PD), an open-source visual programming language, it is possible to teach concepts from auditory perception to generative music. There are many advantages to using open source for education:

> "The purchase of multi-licensed software for audio composition, music typesetting, synthesis and analysis will normally form a significant part of a studio's budget. It is now all too easy for costs to spiral when one becomes tied to commercial products."[6]

There is also the advantage of access, leading to more people being able to find legal versions. It allows version parity when updating software, as no licences are needed to use. Furthermore, the lack of adherence to 'Industry Standards' could also be an advantage as it gives the opportunity to teach skills and theory as opposed to teaching a specific software as "It becomes arbitrary what brand is used"[6].

2.2 Pedagogy

2.2.1 What is Pedagogy?

Pedagogy is defined as "The art, occupation, or practice of teaching" or "the theory or principles of education" [11]. This simply means the way in which we teach. It is difficult to confirm exactly when the idea of teaching was first put into practice, but many associate the Socratic Method with the earliest forms of Pedagogy. The Socratic Method was first proposed sometime in the 5th century BC, where teaching took the form of a 'cooperative argument' where asking questions was supposed to prompt critical thinking practice [12]. These mimics the critical thinking practices found in a studio environment or the problem-solving when debugging code.

2.2.2 Teaching and Learning Styles in 'Music Technology'

The topic of 'Music Technology' is usually situated behind a computer coding or in a studio, thus it is easy to assume that kinaesthetic is the primary source of learning. However, visual representations of equipment and processes can help to explain complex concepts which we would not otherwise hear. The auditory nature of the subject means that our ears and ear training play a substantial role in learning the skills required for course aim completion. An example of this is the traditional analogy of a compressor and a ratio chart shown in a plugin such as: Waves' C1 (shown below)

Figure 2.5: Waves C1: The ratio display in the top right gives visual feedback for what would otherwise be an abstract concept. [13]

Music technology could be argued to engage all three of these learning styles: kinaesthetic, as you are often touching and interacting with the audio directly; aurally, as you are listening for the changes which your input is conveying; and visually, as you often look to a visual representation to see these changes too. Historically visuals were often represented by the reading on a knob or on a VU meter. Although VU meters were representative of level and gain reduction, it was often 'dialled in' by the ear of the engineer allowing for a less visual experience. However, using visual metaphors for analogue processes such as VU meters and knobs have followed through into software design. This causes the phenomenon of mixing with ones eyes oppose to ones ears.

This mix of skills and teaching styles heavily favours a skill-based curriculum, opposed to a content based one. The application of knowledge and the way which all styles of learning culminate in a product is a fantastic example of the IB's own concept-based teaching inside music technology.

2.3 The International Baccalaureate

2.3.1 What is the IB?

The IB Diploma Program (DP), first offered in 1968 [14] encompassing ages 16-19 is a program which aims to develop "inquiring, knowledgeable and caring young people who are motivated to succeed"[15].

The International Baccalaureate Organisation's (IBO) website states that the IB's programmes are different from other curricula as they:

- encourage students of all ages to think critically and challenge assumptions
- develop independently of government and national systems

- incorporating quality practice from research and their global community of schools
- encourage students of all ages to consider both local and global contexts
- develop multilingual students

The IB DP curriculum is composed of six subject groups and the DP core. The six groups are:

- language and literature
- language acquisition
- individual and societies
- sciences
- mathematics
- the arts

For the IB Diploma, a student must study one subject from each of these categories. However, a student may study an additional science, individuals and societies, or language in place of arts. The student must pick three or four subjects to be studied at Higher Level (HL) with the remainder at Standard Level(SL). Each SL subject will take 150 teaching hours, with HL taking 240, there are also different components to the exams for SL and HL. An example of a combination of these are: English Literature (SL), Spanish B (SL), Mathematics (SL), Physics (HL), Music (HL), and Information Technology in a Global Society (HL).

	Standard Level	Higher Level
Group 1	English Literature	
Group 2	Spanish	
Group 3		Information Technology in Global Systems
Group 4		Physics
Group 5	Mathematics	
Group 6		Music

The IB Core consists of three components: Theory of Knowledge (TOK), the Extended Essay (EE), and Creativity, Activity, Service (CAS).

TOK prompts the student to ask difficult questions regarding knowledge and the acquisition of knowledge. This is in the aim of making more inquisitive and curious students, so the style of questions asked are often open-ended and very difficult to explain simply. An example of a TOK question from 2017 was:

> "It is only knowledge produced with difficulty that we truly value." To what extent do you agree with this statement? [16].

This type of question asks the student to define difficulty, look at the impact of knowledge, and question how we value knowledge. This type of abstract thinking is often asked to be displayed in a presentation and an essay.

The EE asks a student to conduct research into an area of their choosing, much like a dissertation or thesis. There is a proposal given to the head of the department and a research supervisor is selected. Giving the student a portion of the final term and the summer of their first year to write their essay, limited to 4000 words. This gives the student the opportunity to explore an area unexplored by the IB or far above the level of the IB DP Curriculum. Examples of previous IB titles include:

> "What level of data compression in music files is acceptable to the human ear?"
>
> "The effects of sugar-free chewing gum on the pH of saliva in the mouth after a meal."
>
> "A study of malnourished children in Indonesia and the extent of their recovery after a period of supervised improved nutrition."[17]

The CAS portion runs similarly to the British Duke of Edinburgh Award or the International Award, where a student dedicates extra curricula time to a creative, action and service task. These are supposed to widen the students' opportunities through a range of purposeful activities, and prompt reflection on personal learning. It is also mandatory that the student takes part in at least one CAS project. These projects are supposed to be "beneficial for the community as well as providing a learning opportunity for the student"[18].

2.3.2 How does the IB implement subjects?

The IB reviews their diploma curricula on a seven-year teaching cycle. This is to stay current with research and teaching techniques evolving. This process includes Examiners/Moderators, Teachers, Consultants and the IB Staff.

The document 'A Guide to Curriculum Development'[19] available on the IBO's website presents the process taken to re-evaluate and iterate on a subject. The process is split into three distinct phases: Evaluation, where they take reports from examiners, survey data, literature reviews, syllabus comparisons and feedback from universities; Development, where meetings with the parties, teacher surveys, review committees and new assessment tasks and criteria are formed; and finally, Implementation, where the production of new materials, workshops, subject specific seminars and accreditation are put into place [19].

As described, the first three years of this review cycle are dedicated to evaluation before another three of development, with a year to spare for implementation. During this time, the IBO follows seven key tenets which inform and aim to strengthen the curriculum.

This is firstly done through research where strengths and weaknesses of the current course are evaluated, including school feedback. The IBO also evaluates the path coming from other IB programs and how a similar learning/teaching style can be maintained. These seek to inform the IB on the current state of the course, allowing for conclusions to be synthesised as to what works and what does not.

The IBO then consults and collaborates with examiners, external advisers, and higher education institutions in the hope of gathering research to inform how the curriculum is being received from outside the IBO.

The curriculum is then put under scrutiny to validate the IB mission and IB learner profile, which includes questioning the global importance of the subject and how international and cultural differences can be reflected in the content.

The assessments are then investigated for their role in the learning experience. A strong focus is put on the assessments resembling real-world situations and requiring the student to display higher-order cognitive skills such as application and synthesis. The IBO deems this to be a greater skill than simple regurgitation of the content.

The next step involves the documentation of the decisions made to influence the curriculum and the research and resources to back up and decisions made. This is for the IBO's reference later in the curriculum's cycle.

The documents and supporting material are then created to inform the wider community about how the curriculum is constructed, in addition to what content is present. These are produced with sufficient time to allow for schools to adapt and implement the new specification.

Finally, the IB documentation and training is given to workshop leaders to provide up to date and factually accurate workshop materials to educators around the IB teaching community [19].

A School-Based-Syllabus (SBS) is usually conducted by the school and is run for up to seven years before entering 'Pilot' stage. They are expected to have at least 20 students after three years and 40 after five. Should after seven years the population fall below 50 then the syllabus is discontinued. If the syllabus has between 50 and 100 students, then the Internal Review Meeting (IRM) will decide whether to discontinue it or not. If the number of students is above 100 then the 'Pilot' stage may progress.

2.3.3 Latest changes to the IB Music

During the reflection of the 2014 Music DP course in 2016 a report proposed the extended use of music technology[20]. In the overview section for the new course, 'Music Technology' is listed as one of the four areas of inquiry. The IBO list that the different uses of music technology which they encourage schools to expand its use are:

- recording music or sounds
- synthesis of new sounds
- processing and editing sound and music
- programming music, such as sequencing and automation
- using computers or other devices as instruments
- using apps and specific software to create and/or perform music

These examples attempt to cover three of the four pillars of 'Music Technology': production, technology and art, the science pillar is not covered. In this report, it is suggested that new assessment tasks are implemented. In these 4 tasks, there are only three mentions where the student interact with the music technology area of interest as a compulsory part of the assessment.

During the 2019 review, reference to music technology was only mentioned twice as a possible avenue to pursue[21]. However, the 2020 brief for the Music DP mentions that:

> "By the end of the course, students will have: engaged with music technology as a compulsory part of the course"[22]

Though it does not dive into any further depth on this matter, the subject 'Guide' is far more extensive.

2.3.4 Music Diploma Program 2020 Guide

The Music DP 2020 Guide serves as information to the public and to the teacher or educator as to what exactly students will learn/teach. A subject brief however, is aimed towards the parents or students to inform them in a shorter form, typically a page or two, what they will learn during the course. This guide is aimed at the 2022 graduate assessments, this means that it starts teaching in 2020. An overview of the syllabus, currently is split into four syllabus components:

Exploring music in context
When exploring music in context, students will learn how to engage with a diverse range of music that will broaden their musical horizons and provide stimuli to expand their own music-making. Students will demonstrate diversity and breadth in their exploration by engaging with music from the areas of inquiry in personal, local, and global contexts.
Experimenting with music
When experimenting with music, students connect theoretical studies to practical work and gain a deeper understanding of the music they engage with. Through this theoretical and practical work as researchers, creators and performers, students will learn to experiment with a range of musical material and stimuli from the areas of inquiry across local and global contexts.
Presenting music
When presenting music, students learn to practise and prepare finished pieces that will be performed or presented to an audience. In working towards completed musical works, students expand their musical identity, demonstrate their level of musicianship, and learn to share and communicate their music as researchers, creators, and performers.
The contemporary music maker (HL only)
Music at higher level (HL) builds on the learning of musical competencies and challenges students to engage with the musical processes in settings of contemporary music-making. For the HL component, students plan and collaboratively create a project that draws on the competencies, skills and processes in all of the musical roles of the music course and is inspired by real life practices of music-making.

Figure 2.6: The four components of the IB Music Syllabus [22]

The course is then broken into four areas of inquiry which the teacher should use to complete these components:

1. **Music for sociocultural and political expression**
   This area focuses on music that expresses and communicates social and cultural messages, conveys political ideas and/or helps preserve social and cultural traditions. Examples of relevant musical materials may include the following genres.
   - Protest songs
   - Liturgical music
   - National anthems
2. **Music for listening and performance**
   This area focuses on music that expresses and communicates intrinsic aesthetic values. Such music is sometimes referred to as "absolute music". Examples of relevant music materials may include the following genres.
   - Chamber music of the Western art tradition
   - Cool jazz
   - Experimental music
3. **Music for dramatic impact, movement and entertainment**
   This area focuses on music used for dramatic effect, music that supports choreographed movement or dance and/or music that is incidental or intended to purposefully serve as entertainment. Examples of relevant music materials may include the following genres.
   - Music for film
   - Music for ballet
   - Musical theatre
4. **Music technology in the electronic and digital age**
   This area focuses on music created, performed and/or produced using electronic or digital technologies. Such technologies are an important aspect of contemporary musical experiences, often transforming some of the ways that we understand and engage with music. Examples of relevant musical materials may include the following genres.
   - Electonic dance music
   - Elektronische Musik
   - Technology in popular music production

Figure 2.7: The four areas of inquiry in the IB Music Syllabus [22]

Music technology in this guide occupies a small section labelled 'The role of music technology in the course':

> "New technology has always been a driving force behind the development of musical genres, styles, and practices. At the same time, new and emerging music can also foster and extend technological innovation. This dynamic and mutual influence is at the heart of the contemporary musical experience and has transformed both music-making and musical education." [22]

The guide reiterates the possibilities that the integration of music technology could offer. In addition to this it offers suggestions to how music technology could contribute

to wider areas of the IB such as TOK, CAS and the EE. 'To what extent does technology enhance and hinder creativity?' is an example of a potential TOK investigation, with Audio engineering an album being suggested as a CAS project. The example for the EE involves using technology as a performance, M4SONIC is cited as an example of using a 'Novation LaunchPad' to enhance a sample trigger session with programmed light-up pads.

The course structure as a whole now revolves around four 'Areas of Inquiry', one of which is "Music Technology in the electronic and digital age" [22]. In general, the direction and freedom given to teachers has increased. This means that teachers are able to teach the course in whatever order and style they wish, as long as they fill these 'Areas of Inquiry'. As a disadvantage, this means that support for the teachers in areas such as 'Music Technology' has reduced, as there is little direction for less technologically literate teachers. This only emphasises the need for experts of the subject inside the IBO giving direction, adopting a course in 'Music Technology' is a method of giving teachers the resources and allowing for further development for the students who wish to pursue it.

2.3.5 Assessment of Music Technology in the IB

An interesting distinction made is that in assessments:

> "all parts must be MIDI entered, or performed and recorded, by the student. Sampled parts and drum loops are only acceptable if the teacher can verify that the samples have been performed or recorded by the student" [22]

This calls to question whether this restriction harms the cultures and musical styles which rely heavily on sampling, such as Hip-Hop and RnB. It could be that the use of the phrase 'sampled parts' could refer to pre-made loops and sounds purchasable in 'sample packs'. In which case, if these samples were loaded into a Drum Machine VST, such as Native Instruments' Battery [23] it could be 'MIDI entered', circumnavigating the restriction. An additional problem with this wording is that it does not reference 'sampled instruments' such as Native Instruments' Kontakt [24], where instruments are 'sampled' by professionals in controlled environments. This idea of not using samples would severely hinder the possibilities of the default Digital Audio Workstation (DAW) for education 'Garage Band'. Expecting every single element such as: drums, piano, orchestral to be recorded or synthesised by the student makes many productions infeasible.

The assessment criteria for 'Presenting Music' or Performance also offers the ability for the use of 'Music Technology'. This offers their view on what the IB thinks 'Music Technology' is.

> "The video for music technology performances will be a close-up of the equipment demonstrating the student's manipulation of the musical elements on the instrument(s)." [22]
>
> "Although not recommended, students may combine vocal, instrumental and music technology performances." [22]

The issue with this is that it ignores the idea of coding as a form of performance. It also makes the statement that generative music programs offer no value for performance.

2.3.6 Food-Technology Guide

The plan would be for music technology to be taught as what is known as a School Based Syllabus (SBS). These are usually created due to a country's requirement to teach local history; this is evident with Turkish History and Brazilian Social Studies. In addition to this, IB only provides two multidisciplinary subjects: Environmental systems and societies[25] which can be taken in group three and four; and Literature and performance which can be taken in place of an SL English subject. The groups which these straddles are either the Sciences and Social Sciences, or English and Arts. An example of a School-Based Syllabus which is also a multidisciplinary subject is 'Food Science and Technology'. This serves as a good comparison, as 'Music Technology' would initially be implemented as a multidisciplinary SBS.

SBS are limited in some capacity as they are limited to groups 2 and 6 as well as only being available at standard level. This limits teaching to 150 hours.[25]

The specification makes a point of outlining the differences between food science and food technology, which is important as defining a subject sets its boundaries and applications. The specification contains lists on what 'Food science and technology' offers the wider populace, what a food scientist and technologist needs to be able to do and states the role of Food inside of Science and Technology. This approach of setting the groundwork makes the process of developing a curriculum easier to develop as the specification aims to work towards completing those requirements.

The specification also features a section where it describes its value towards the core of the IB, relating the course to its impact on the nature of the knowledge. The guide also offers questions which could be used in the TOK presentation and paper. International Mindedness is a key component to the concepts taught in the IB; the guide uses science as a mediator to display the course's international impact. Globalisation and its role in acculturation is a key point proposed. "Globalisation of food has impacted on lifestyle in most parts of the world, both positively and negatively." [26] The guide explains the links to the 'IB Learner Profile', this displays that the aims outlined later in the guide related directly to what the IB expects from its students. In addition to this there are links to the programs before and after allowing for a seamless transition from the Middle Years Programme all the way through to the IB Career-related Programme.

This guide allows for the creation of an SBS in the format of the IB. It informs on how to present the information and what sections to focus on when creating a syllabus. This combination of SBS and a Multidisciplinary subject is a useful source as it proves that this sort of subject is possible and approved by the IBO.

2.3.7 Music Technology in the IB

Although teaching is limited to 150 hours, it is important to plan ahead for a full scale course. The allowance in the IB is 240 teaching hours at HL and 150 at SL. This allows 60 hours for each of the four pillars at HL, and only just above half that for SL. Some subjects such as 'Physics' make certain portions of the subject HL only. This would be the approach to implement, as it would maintain depth over breadth. This presents a challenge for the teacher which would require teaching different content for HL or SL, alternatively the teacher could teach the entire content of HL and the SL students simply do not attend the pillar which they have dropped. However, the School Based Syllabi are limited to SL subjects and 150 teaching hours. This means that some areas may have to be omitted to keep teaching at a high standard and to avoid rushing.

An example of the areas being implemented in this form are as shown below:

Syllabus Component	Teaching Hours	
	SL	HL
Production	40	60
Technology	40	60
Art	40	60
Science	30	60
Total teaching hours	**150**	**240**

2.4 Content of the A-Level

2.4.1 Assessment Specification

The 'Music Technology' A-Level offers three areas of study: Recording and Production Techniques, Principles of Sound and Audio Technology, and The Development of Recording and Production Technology. Across these three areas, four components are listed: Recording, Technology-based composition, Listening and Analysing, and Producing and Analysing [27].

Component 1: Recording

The first area of study is broken down into distinct topics:

- Software and Hardware
- Capture of sound
- Audio Editing
- Pitch and Rhythm
- Correction and manipulation
- Automation
- Dynamic Processing
- Stereo
- EQ
- Effects
- Balance and Blend
- Mastering

This mimics a possible work flow when creating a piece of music within a DAW. The assessment seeks to create an ensemble which is akin to a rock band, with a drum kit, guitars, lead and backing vocals. An interesting requirement is a minimum of four microphones on the drum kit. This lack of experimentation signals to the student that it is either not worth experimenting or is deemed unfit for purpose. In the context of a rock band it is typical that a drum kit would be close micced. However, not allowing for this experimentation could lead to a lack of learning in accurate microphone placement and using the minimal resources.

With the limitations of the recording assessment and the lack to create and experiment, it could be argued that this stifles creativity in the studio and could lead to less innovation in the recording industry. Although it could also be argued that this is what a recording

engineer would be faced with, limitations and the songs created by an artist without room for interpretation or creativity. In addition to this, the limitations mean that when marking, it is easier to mark against a reference track. The submission for the assessment is simply a recording and a logbook regarding the equipment, techniques and instruments used in the recording. This does not allow for any kind of explanation of the production techniques or creative decisions during the mixing process, of which, may not come across in the pure recording. This leaves marking to be purely based on the recording, with no commendation to the skill or craft that comes from mixing or mastering. This contrast the fact that assessment grid 2-7 are specifically regarding mixing, with no opportunity for a student to defend their decisions. This once again stifles the creative process and limits the students' options. With an industry which is moving more and more towards independent creators and bedroom producers, the A-Level is set on creating a scenario which very little will ever experience.

Component 2: Technology-based Composition

The second component of assessment is a Technology-based Composition where the students will be assessed on skills of creating, editing and structuring. This is broken down into topics much like the first component, many of which they share. New topics include Synthesis, Sampling, and Sequencing. The student is asked to compose and produce music for one of three briefs, in the past this could have been a video in need of music, a poem which could have music composed into a song, or the most interesting is a sampling project from creatures of the Mariana Trench as was presented in 2019. This gives the student a prompt but does not dictate the style of the piece, allowing for a more open-ended assessment. In addition to this, the logbook allows the student to not only justify creative decisions but also list sources of samples, meaning that there is no limit to what someone might use.

Component 3: Listening and analysing

The third component: Listening and analysing allows the student to develop understanding of 20th century popular music styles in addition to wider listening. In addition to the previous skills, the student must develop skills in: Acoustics, Leads and Signals, Numeracy, and Levels. This leads into learning about the different methods of record production, including knowledge of hardware analogue devices. This assessment comes in the form of a technical paper, asking the student to listen and analyse up to six different extracts of music. This will test the students' knowledge of practical creative effects and production.

Component 4: Producing and analysing

The final component is interesting, as the assessment is a culmination of all that has come before. It puts the student in front of a DAW under time constraints and asks them to perform tasks according to questions or recording scenarios. This is then graded on both the paper and the audio exports.

Perhaps the most valuable data which can be taken from this source is the 'Progression' where it is stated what a student can do after this subject. It is listed that progressing to University or Music Schools is a possibility in addition to industry as a 'trainee producer or engineer, studio manager'. Applying Boehem's 'Tetrad of Music Technology' we can see that the A-Level qualification only prepares a student for, at most, three of the four

pillars. There is little mention of the 'Science' pillar, with relation to Software/Hardware Development or the in-depth study of how DSP is constructed. In addition to this, there is no mention of circuitry or the electronics behind how analogue systems work. This shows that even the A-Level qualification is not infallible when giving its own definition for what 'Music Technology' entails.

This assessment criteria is a valued source as it gives ideas as to how the IB could implement assessments for a 'Music Technology' portfolio or paper. It is also useful as it gives a good representation of what another education body deems useful in the eyes of higher education in the UK.

2.5 The argument for Music Technology in the IB

Throughout this chapter, the argument of 'Should the IB have a 'Music Technology' course?' has been challenged. With the A-Level qualification proving that certain elements such as sampling do not need to be omitted if citations are provided and, due to the growing dependency on digital technologies, it is clear that a music technology course would not just fit in, but would thrive in the structures of the IB. In addition to this, the pedagogical impact of combining learning styles and covering the whole range of what 'Music Technology' is, it is possible that the inclusion of such a course could bridge the gap for students interested in the topic and wishing to pursue it at higher level education. Due to pedagogical styles, interdisciplinary, and the current market, music technology would make a great addition to the already fantastic roster available to students of the International Baccalaureate Diploma Program.

Chapter 3

The Syllabus

The process of writing the syllabus started by analysing how multiple IB Guides are written and what voice they are presented in. This then followed onto looking specifically at how the music syllabus was written, and if there were any sections which could be borrowed from to form a section of the syllabus. This took the process of finding specific methods and techniques that are used to allow knowledge to be taught. For some sections there were aspects of music which were considered and for others the physics subject guide were referenced.

First a document was drafted with all of the sections present in all guides. These include sections such as: 'the purpose of this document' and 'nature of the subject'. After these were put in place and had program specific sections copied over, the writing of the syllabus could start. However, the content of the course would mean nothing if the teaching itself was insufficient. This meant that Pedagogical technique and approaches to teaching and learning were considered.

3.1 Teaching and Learning

3.1.1 Pedagogical approach

Taxonomy of Educational Objectives

Bloom's taxonomy of educational objectives published in 1956 [28] was intended for use in higher education, however, as knowledge has developed it has found it's way into earlier in development and even broadened its impact to a wider application than simply humans.

1. **Remembering:** Retrieving, recognising, and recalling relevant knowledge from long-term memory
2. **Understanding:** Constructing meaning from oral, written, and graphic messages through interpretting, exemplifying, classifying, summarising, inferring, comparing, and explaining
3. **Applying:** Carrying out or using a procedure through executing or implementing
4. **Analysing:** Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organising, and attributing
5. **Evaluating:** Making judgements based on criteria and standers through checking and critiquing
6. **Creating:** Putting elements together to form a coherent or functional whole; reorganising elements into a new pattern or structure through generating, planning, or producing

Figure 3.1: The six objectives for learning, these should all be completed in order for a student to fully experience the knowledge. [29]

The intention of the modules is that they are designed in such a way as to allow students to progress from simple remembering all the way to creation within the given task. This is where Project-based learning allows students to extend their grasp on the subject and further their own workflow.

Project-Based Learning

Project-based Learning (PBL) will be the primary style during the course. Giving the students a goal to work towards and relating everything taught back to the application of the project will give context and validity to the content taught.

The Four Phases of PBL

The Buck Institute for Education has identified four phases that happen in every well-designed project.

1. **Project Launch:** This typically starts with an entry event to ignite curiosity and introducing a driving question to frame the inquiry experience
2. **Knowledge building:** Students build background understanding and learn nedw skills to help them answer the driving question
3. **Product development and critique:** Students apply what they have learned to create something new (such as a product, solution, or recommendation)
4. **Final presentation and reflection:** Students share their polished work with an authentic audience

Figure 3.2: The four stages of PBL, these are intended to be followed in order for the project to be a success. [30]

Specific skills required for PBL are often integrated into all forms of teaching. This means that implementation would not pose as much of a hindrance, as many of the skills will have already been learned.

> "From the earliest elementary years to the most advanced high school courses, students engage in projects through questioning, researching, close reading, analysing, and, often, multimedia writing and publishing." [30]

Much like in the industry, working as a pair or in a team is important to develop social and communication skills. PBL allows this, as often research roles and the process of research is one of collaboration.

> "When students collaborate with peers, consult with content-area experts, or make public presentations of their findings, they use communication skills. Across curricula, these familiar skills are indispensable in PBL."[30]

This sense of communication and collaboration is how the syllabus is written. Often during the time constraints there will be too much for a single person to complete, thus the research and development of an idea or product will be done with another person. This promotes the idea of studying a student's interests within a group to create a diverse group of knowledgeable individuals which can specialise inside of a team. It also prompts learning in leadership skills and delegation of time and tasks.

Conceive Design Implement Operate

Another approach which stresses the fundamentals of engineering is the Conceive Design Implement Operate (CDIO). This framework uses group projects and PBL as a tool for education.

- Disciplinary knowledge and reasoning
- Personal and professional skills and attributes
- Interpersonal skills: teamwork and communication
- Conceiving, designing, implementing, and operating systems in the enterprise, societal, and environmental context

Figure 3.3: The four parts of the revised syllabus [31]

The application to the syllabus is that often the area of music technology is split between engineering and music jobs and straddles the subject boundaries. This means that different approaches should be taken for what works best for each section. Keeping the reflective style of the arts with the learning of CDIO creates an effective method of teaching music technology.

3.1.2 Looking through another's eyes

The IB puts emphasis on creating a caring and compassionate student with the ability to understand different points of view. In the same way, this course borrows a significant portion of the music syllabus as it is able to meet and exceed this requirement throughout the course. Seeing the subject through different points of view will give a new perspective

on the subject and allow for further development into the skill set and knowledge required for each career. The reason for the three view points is that they each represent a portion of what an active practitioner would do during a project. Each project will require an aspect of research in order to gather resources or a knowledge base to use. Next a student will use the skills of a creator in order to create an item in their portfolio, finally, the performer is introduced where by the student will either perform or present their product. This is where once again the researcher comes back around and evaluates and studies the product in order for the cycle to start again.

Looking through the eyes of others allows us to develop our understanding of the creative process and the roles which we inhabit during the time spent on a project.

The Researcher

As a researcher, the students are expected to investigate and engage in academic texts, seeking explanations to problems or phenomena. They will develop an ability to look for practices and examples of a given technique or specific method and critically analyse how or why they are done. When learning the module content, the student will learn to:

- Identify and Analyse:
  - studio techniques
  - signal processing
  - performance techniques
- Make connections between:
  - technical knowledge and applied techniques
  - theoretical knowledge and the creative medium
- Analyse:
  - the effectiveness and application of the scientific method
  - technical knowledge using accurate terminology and theories
  - current market trends and best practices
- Experiment:
  - using technical knowledge and practised techniques
  - using the scientific method
- Develop:
  - an ability to source knowledge from beyond the scope of module content
  - an ability to apply outside knowledge to module assessments

Educators are encouraged to provide regular opportunities to allow students to practice research and writing skills. This could include activities on sourcing information and analysing the bias, time period and intention of the source. Activities stretching the student's grasp on the academic world paired with effective and detailed feedback will allow the student to grow their skills in identifying and analysing crucial sources of information.

Figure 3.4: Appendix 1 p.16

The Creator

Engaging with this course as a creator means allowing students to test their own ability to create a product. With the vocational style that the course presents, the student is encouraged to experiment and explore the methods of creation in the subject of Music Technology. When learning the module content, the student is expected to:

- Practice:
  - studio techniques
  - creative use of effects
  - composition techniques
- Make connections between:
  - the creative process and music composition
  - the creative process and studio training
- Analyse:
  - the effectiveness of musical and technical content
  - the place and relevance of specific techniques and methods
- Apply:
  - theories and technical knowledge to the medium of sound
  - relevant theories to the creation of experiments

The educator is encouraged to provide opportunities for the student to create their own examples of many of the taught methods. Creation is a vital part of learning in Music Technology, as so much of it is a meld between theory and practice. Creation of a product through project-based learning can help reinforce teaching and further develop the student's skills.

Figure 3.5: Appendix 1 pp.16-17

The Performer
Engaging with the course as a performer means allowing the students to gain confidence in their ability to present musical, artistic, or academic work. With many career opportunities in this field relating to the medium of live performance, it is important to reinforce learning with the possibility to present that work.

- Explore:
  - the adaptation of pre-recorded material in live performance
- Make connections between:
  - the performance of others and their relevance to production
- Display application of:
  - layered complexity in composition
  - relevant learned skills
- Display understanding of:
  - protocols and methods
  - interactive design
  - era and genre and their relevance to performance
- Identify:
  - appropriate tools and techniques
- Demonstrate:
  - an awareness of theories and their application to performance

The educator is expected to encourage the students to engage with performance activities throughout teaching. These activities can range from concerts to simple presentations. It is also expected that the viewpoint of 'The Performer' is reflected on regularly in each module. This relates to how material could be transformed from premade to performance or vice versa. Activities which reinforce this learned skill will help further develop an appreciation for performers and consolidate skills learned on the course.

Figure 3.6: Appendix 1 p.17

3.2 What should be taught?

3.2.1 Tetrad of MT

As stated in the background, Boehm reformed the 'Triad of Music Technology' in 2018 to form the 'Tetrad of Music Technology'. The inclusion of all areas is important as it gives someone the best opportunity with university courses. From a small subset of the 'Music Technology' courses offered at university in the UK, an investigation into what modules and portions of the Tetrad were covered was proposed.
The six university courses looked at were:

- Sussex - Music Technology BA (Hons) [32]
- University of Winchester - Music and Sound Production [33]
- Glasgow Caledonian University - Audio Technology BSc (Hons) [34]
- University of Kent - Music Technology and Audio Production BSc (Hons) [35]

- Bournemouth University - Music and Sound Production BA (Hons) [36]
- University of York - Music and Sound Recording BA (Hons) [37]

As each course is slightly different, it is important to stress that not all the modules were analysed as they often only appeared in a single course. This is significant as each university may choose to specialise their course in a specific way depending on department. This means that not all modules in the course could be considered as part of music technology but would contribute greatly to further understanding. An example of this is a maths module, where the skills learned could be applied to many areas of music technology, but the focus of the module is often diverted. Each of the modules presented appear in more than one university course. The total from this is taken to see what the most popular module is. This gives an indication as to what module is most important in the eyes of multiple universities and not just one. This is then averaged to find the most valuable sector of the Tetrad of Music Technology in the eyes of multiple universities.

	Module Type	Sussex	Winchester	Glasgow Caledonian	Kent	Bournemouth	York (Mus)	Popularity by Module Type	Average by Area of Tetrad
Art	History of Electronic Music	x					x	2	
	Community		x		x			2	
	Original Composition	x	x		x	x		4	
	Digital Music Cultures	x	x		x	x	x	5	
	Critical Listening				x		x	2	3.00
Production	Creative Music Tech	x	x		x	x	x	5	
	Music Production	x	x	x	x	x	x	6	
	Electronic Music and Performance	x	x		x		x	4	
	Sound Design For Media	x	x	x	x	x	x	6	5.25
Science	Programming			x	x		x	3	
	Circuits			x	x			2	
	Sound Theory (Science)		x	x	x		x	4	
	Acoustics/Spacial			x	x			2	2.75
Technology	Studio Recording	x	x	x	x	x	x	6	
	Live Sound		x		x			2	
	Interactive Music Systems	x	x		x	x	x	5	4.33

Figure 3.7: A table to show the population of modules, compartmentalised into the four areas of the 'Tetrad of Music Technology'

From this data a conclusion could be drawn that the Technology and Production are the most valuable sectors of music technology, with Studio Recording, Music Production and Sound Design for Media equal as the most valuable module. This will inform the types of modules which are often used in level-3 education standards. This way, the knowledge which is presented to the students can be further built on during their time at university if they choose to pursue higher education. However, it also allows a student to enter an internship or apprenticeship, as they should have been taught the necessary skills to compete in the workforce.

3.2.2 The Overview

Syllabus outline

From the 'Tetrad of Music Technology' we can create four distinct focuses of Music Technology.

- Production
- Technology
- Art
- Science

These areas are further split into two modules which will be taken.

Production

This area allows the student to explore the making of music in a professional context. The applications and techniques to produce music on a computer. It also covers practices linked to the role of an audio engineer, in addition to the systems which enable performances on stage.

- The Bedroom Producer (HL Extension)
- Record Production (HL Extension)

Technology

This area will allow the student to explore the tools which we use to make music. They will get well acquainted with computer-based languages along with the standards and specifications used to communicate digitally.

- Performance and Live Electronics (HL Extension)
- Pure Data and Synthesis (HL Extension)

Art

This area focuses on the recent history of music in conjunction with technology, this includes research and practical components of music technology pioneers.

- 20th Century Music
- Electro-Acoustic Composition

Science

This area directs its attention to the underlying physics surrounding the topic of sound and waves.

- Psychoacoustic
- Waves

Figure 3.8: Appendix 1 p.15

3.2.3 Design through Skills

A trend in university courses surrounding the subject of Music Technology is the teaching of skills and concepts. This often involves not using a single piece of software or hardware, but instead looking at the underlying concepts to be taught.

A small thought experiment was done where Music Technology was broken down into the four components, then further broken into topics which could be covered. Jobs were

then listed which would be linked to the topics, these were cross-referenced to what baseline skills were required for this job to be carried out.

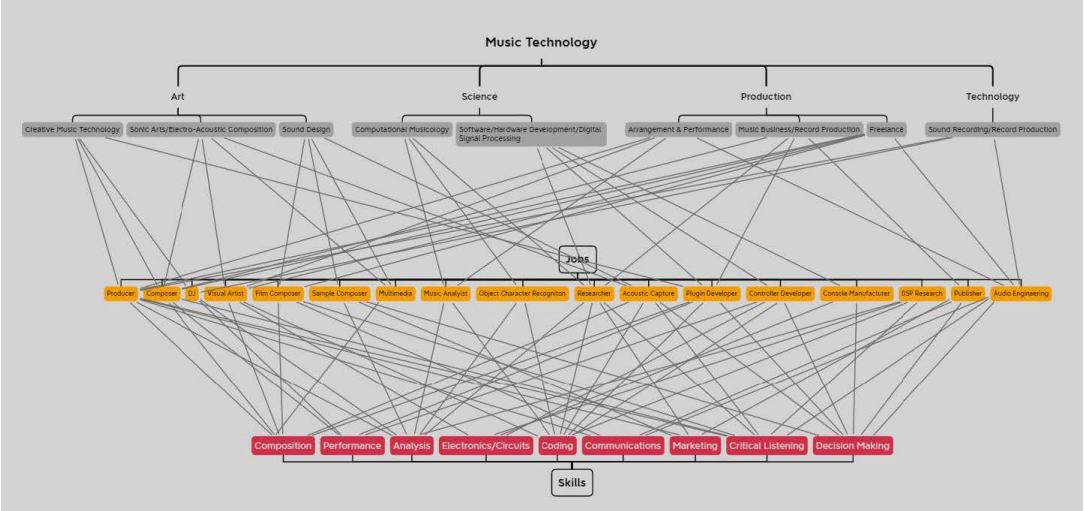

Figure 3.9: A mind map to display the complexity of teaching the whole section of music technology

This was an integral part of forming the content of the course. Each module or section was designed in such a way to develop at least one of these skills. Looking towards university courses related to the subject of music technology, the module choice can inform a potential student as to what knowledge they should have learned. Providing a traceable link between module content and potential careers is also an important aspect, as often knowledge taught in school is no longer needed past the test date. Designing modules based upon a career gives a sense of vocational learning and can ease the transition into the workplace.

Production

The Bedroom Producer module links to the Freelance Music Producer profession, where a person will make their own music in a home studio or a professional rented studio with the intention of selling or otherwise monetising that music. This links to the module due to the knowledge gained regarding synthesis, audio processing and MIDI, which are imperative to making music in a modern DAW.

The Record Production module links to the Mix Engineer or Recording Engineer profession. This is where the person would be situated in a professional studio recording, mixing or mastering music for clients. This links to the modules due to the knowledge gained about signal flow, audio processing and microphone technique, all of which are covered during this module.

Together, these two modules aim to provide skills enough to create music in a digital and analogue medium. Although these skills become very important in the other modules, the core of the teaching is aimed towards the Production career path.

Technology

The Performance and Live Electronics module links to the Live Music Performer or Live Audio Engineer professions. This includes any profession where a person would deal with electronics on or off-stage in some capacity. The use of specific knowledge gained from this module will allow a student to mix and perform using protocols and controllers or synthesisers to create an engaging performance. This module is aimed to introduce these concepts as opposed to providing all knowledge within this sector as there could be enough content to warrant an entire course simply based around these concepts.

The Pure Data and Synthesis module links to a role such as a Plugin Developer. Learning Digital Signal Processing is imperative, and the concepts of synthesis become a focus of this module. The use of specific knowledge in this module will inform choices made when creating or analysing a synthesiser.

These two modules aim to provide the necessary skills to understand, analyse and recreate DSP along with to conduct either the live mixing or live performance. This is done with the understanding and appreciation of how these systems run.

Art

The 20th Century Music module links to the role of Contemporary Composer, where a person would be commissioned or chosen to compose music for the modern era. The knowledge gained from the module would allow for the composition of modern pieces based within the constraints of 20th Century Music. Potential paths surrounding this training could be Music for Media.

The Electro-Acoustic Composition module also links to a contemporary composer; however, this would include technology and specialisation. These could link to careers as an acoustician and potentially a composer for art installations. The knowledge gained and built on during this module allows for the creation of Multi-Source Speaker Arrays and experimental documentation for non-western notation.

These two modules form the base of the music avenue, providing basic music theory and context to the applications of it. They allow the analysis and creation of stylistic music from multiple periods, leading to modern day art.

Science

The Psychoacoustics module links to the avenue of testing the human perception and what we are capable of hearing and interpreting. This could link to psychology or audiology. The skills used during this module allows the student to design an experiment and measure the human perception integrating the scientific method.

The Waves module links to the understanding of our world around us. Perceptive students will learn the way in which we interact with the medium of sound and will be able to obtain information through experimentation and use of the scientific method.

These two modules aim to give an understanding of the science behind the medium of sound and equally how we as humans experience sound. The modules teach the skills to evaluate and critically analyse the testing methodologies to measure the human perception and understand the conclusions derived from such experiments. These skills are based around the Science portion of the Tetrad.

3.2.4 Module Design

The Bedroom Producer

This module aims to guide the student through the process of working inside a DAW to create a piece of music solely on a computer. This is in the aim of introducing several concepts of music production, DSP and sampling. During this module, the student will be expected to learn the functions of a DAW. The recommended DAW to teach is Reaper due to its low price, customisability, and ease of use. Teaching on this will be taught from ground up scaffolding to make sure that concepts of a DAW are taught opposed to a specific function. Areas may include:

- Synthesis
- MIDI
- Mixing

Synthesis teaching should focus on three main methods of synthesising sounds:

- Subtractive
- Addative
- FM Synthesis

These can be done through the DAW or through applications such as VCV Rack where modular synthesis can operate as an introduction to signal flow and synth sections. This should cover basic theory of the synthesis and application, opposed to the technicalities of each type.

MIDI teaching should focus on the applications of MIDI and controlling an instrument, these can include:

- Note Data
- Control Data
- Automation

This can be done using an external controller or the internal automation inside Reaper.

Mixing should focus on using FX units to alter the sound with intent of combining audio signals:

- Levels and Pan
- EQ and Compression
- Reverb and Delay

This should be done within the DAW and should focus on teaching the concepts of how this can affect the final sounds.

Figure 3.10: Appendix 1 p.18

The intent of this module is to kick-start progression using a DAW and synthesis. It is designed in such a way where it should cover atleast a small amount of each of the four points of music technology. The obvious links are to Production and Art with the student composing music themselves, the not so obvious links are the Technology side with mixing practice and signal flow through the DAW, and Science through the use of MIDI and an explanation of reverb and its properties. This introductory module should give the students the skills which they can then develop in spare time or form queries about. The

teaching is formatted in such a way which it should prompt inquisitiveness and a wide-reaching scope. The reason as to the project-based learning (PBL) on this module is that it invites creative thinking and a sense of personalisation to each assessment, one student will not learn exactly the same as another as they are making different music. This will also be an introduction to the PBL format, where the students will go through all four stages of PBL to experience how it is implemented.

Record Production

This module aims to teach the basics of microphone technique and inputting audio into a workstation. These techniques are essential to the production of a record when live instruments are involved. The student is expected to continue work from the previous module learning about functions of a DAW and DSP, however, they are also expected to gain a good working relationship with microphone technique on a variety of instruments. Teaching on during this module will focus on:

- Microphone Technique
- Instrument Experimentation
- Multitrack/Take 'comping'

Microphone Technique focuses on the application of microphones to record instrumental music, this should include:

- Basic signal flow in and out of a DAW
- Polar Patterns and Proximity
- ORTF, Spaced Pair, XY Stereo techniques

This should be taught in the setting of a studio environment to avoid noise pollution and insure concentration on the setup.
Instrumental Experimentation will allow the student to try different techniques on several instruments, these should include:

- Guitar (Acoustic and Electric)
- Drums (at least four mics)
- Vocal (Ribbon/Condenser/Dynamic)

Multitrack comping focuses on the skills of editing a final take from several other takes. This should stress the importance of:

- Crossfades and curves
- Editing and phase
- Noise

Figure 3.11: Appendix 1 p.19

This module is intended to give a good introduction to the basic functionality of microphones and editing skills. With group work remaining the focus of this activity, they will also learn communication skills from within a studio environment. The skills used and developed here will build upon the work and familiarity gained during the Bedroom Producer module. Linking to the Technology and Production portion of the tetrad should allow for a balanced view of production. This aims to introduce and create a good understanding of the DAW.

Performance and Live Electronics

This module aims to introduce the student to the methods of performance when Music Technology is involved. The student throughout the course is expected to perform or be acquainted with the tools and skills required to do so. This module should include elements of:

- Live Mixing
- Communication Protocols
- Electronic Performance

Live Mixing focuses on the aspect of using a mixing console in a live setting, this will make the student used to making decisions quickly and working under pressure. Areas which are covered should include:

- Analogue Mixing Consoles
- Digital Mixing Consoles

Communication Protocols focuses on the education of current protocols that are involved in Music Performance communications; this could be from note data to radio frequencies. Areas which should be included are:

- Network Audio (Dante, AES67, MADI)
- Network Data (OSC, MSC)
- MIDI Protocol

Electronic Performance should focus on the application of technology from the perspective of the performer, this revolves around the tools that a performer would use to create a unique and engaging display. Areas that could be covered are:

- Performance controllers (Novation Launchpad/Ableton Push)
- Performance DAWs (Ableton)
- Reference to other forms of Electronic Performance (Turntables, DJ)

Figure 3.12: Appendix 1 p.20

The intention behind performance and live electronics is to give the students the opportunity to collaborate and create a joint performance using different methods. The importance of live electronics and especially live mixing is something which will aid in studio workflows. This is due to the mixing being far quicker and decisions being made at a faster pace. The links to Technology and Production allow for live performance, however, science is also a key link as the protocols and methods used in a live space are important considerations.

Pure Data and Synthesis Design

This module will centre around learning programs such as Pure Data and Supercollider to teach different approaches to synthesis. This is aimed to reinforce and delve deeper into synthesis introduced in The Bedroom Producer. Much like the module's synthesis focus, this module should use Pure Data and Supercollider to create a synthesiser of each kind:

- Subtractive
- Additive
- Modulation

Additional types of synthesis such as granular, wave-table or single cycle sample can be explored during this process.

Subtractive synthesis focuses on creating a complex generator, then utilising filters to pull back layers and shape the sound. Synths that could be listened to and studied are:

- Moog MiniMoog
- Roland SH-101
- Korg MS-20

This exploration is designed to inform the student on the different sounds and techniques used by the makers and performers.

Additive synthesis focuses on generating a rich harmonic structure with sine and cosine waves. Areas which could be explored are:

- Church Organs
- Hammond Organs

This exploration can show the wealth of possibilities with a simple wave if used in a way to mimic real life harmonic structures.

Modulation Synthesis opens the doors to a wealth of sounds and possibilities. This can range from control speed to audio speed to create different sounds. Areas which could be explored include:

- Frequency Modulation
- Amplitude Modulation
- Phase Modulation

This exploration can demonstrate the breadth of modulation possibilities and how these can be included into other forms of synthesis.

This module is also based around the idea of using programs for performance, this can be done through custom-built sequencers and routines made utilising the synthesisers which have been built. There is also an expectation of a form of GUI which can be made in both programs.

Figure 3.13: Appendix 1 p.21

Understanding of synthesis is an integral part of Digital Signal Processing. The creation of many kinds of synthesis allows an in-depth look at innovations made throughout the history of synthesisers. Starting from simple subtractive analysis all the way to phase distortion and granular allows for a vast amount of breadth and depth in the topic. This teaching is in the aim that the students use this knowledge in later modules to inform their

choices in production-based modules. Links to Science and Technology are clear in the experimentation and coding side of the module. The links to Art and Production come in the form of generative music in the 20th Century and the stylistic decisions made during a production process which could be informed by the sound and therefore design of DSP.

20th Century Music

This module should focus on the applications of music technology during the 20th century. This should not focus on a specific genre or set of artists, this is in the aim of creating a well-rounded exploratory module. There are a few recommended areas which the student may choose to focus their interests:

- Popular Recorded Music
- Early Electronic Music
- Contemporary Classical

Popular Recorded Music is focused on the way in which music was recorded during the late 20th century and the influence of the new medium. Areas which could be focused on are:

- 1960s
- 1970s
- 1980s

This is designed so that the exploration of these eras informs aesthetic choices in a recording or mixing environment, should a student wish to recreate an era's sound. Early Electronic Music focuses on the application of synthesisers during their infancy. Artists who could be studied are:

- Beetles
- Kraftwerk
- Tangerine Dream

Contemporary Classical looks at the use of technology during the pioneering area of 20th Century music. Composers or areas using technology in new and novel ways, could include:

- Pierre Henri Marie Schaeffer
- Karlheinz Stockhausen
- John Cage

This module's goal is to open the doors to new and interesting styles and analyse how big of an impact music technology has had on our modern world. The student is expected to reflect upon the advancements and innovations that allow our modern music to be created.

Figure 3.14: Appendix 1 p.22

20th Century Music is an important topic to cover, as basic knowledge of music theory is recommended for anyone entering a music technology course at university. This is especially so if the course is taught from within a department of Music. Another benefit of this is allowing the students to effectively communicate with musicians when in a studio environment. Knowledge and understanding of the source material can inform aesthetic choice of microphones, techniques, and processing. Allowing the past at least 100 years

of music should allow for an adequate understanding of these principles. Links to Art in this module are the focus, however, links to the artistic direction in Production could also be considered.

Electro-Acoustic Composition

This module is concentrated around using the skills which have been developed so far and channelling it into an electro acoustic composition. This is designed to focus on utilising an acoustic instrument with specially engineered effects to create an engaging and exciting composition. Areas which a student may wish to explore could be:

- Multi Source Arrays
- Experimental Notation
- Minimalism

Multi Source Arrays focuses on the use of more than one speaker as a means of conveying movement throughout a piece. This can include technologies such as:

- Ambisonics
- Quadaphonic
- 5.1 and 7.1 Surround

Experimental Notation links to non western notation and the application of other forms. Study of pieces in which experimental notation were used could include:

- John Cage - 4'33"
- Sylvano Bussotti
- Allison Knowles

Minimalism focuses on usage of minimal or simplistic features which are repeated to form a piece. This often refers to certain techniques which change the piece over time. These techniques could include:

- Phase Shifting
- Note Addition
- Rhythmic Transformation

Figure 3.15: Appendix 1 p.23

This is designed to take the knowledge and compositional styles from the 20th century and apply it to new material. This is in the aim of introducing new methods of notation, special audio and compositional techniques. This combines the Art links of 20th Century Music and the Production focus of The Bedroom Producer.

Waves

This module is centred around the science and physics behind the medium of sound. It is designed as a content forward introduction to the physics of waves, including areas such as:

- Simple Harmonic Motion
- Reflection
- Nodes and Antinodes

Simple Harmonic Motion is focused on introducing the aspect of oscillation and utilising the unit circle to explain aspects of how oscillations work. Areas which could be used to explain this are:

- Mass and Spring model
- Pendulum model
- Relationship of Sin and Cos

Refection should be centred around the idea of acoustic properties and the relationship between absorption and reflection. This can be taught practically by visiting different spaces and assessing how each place sounds, then backed up by recordings and readings from that space. Areas which could be used to explain this are:

- Absorption and Scattering Coefficients
- Acoustic Diffusion
- Acoustic Parameters

Nodes and Antinodes should focus on the aspects of analysing the possibility of waves causing constructive or destructive interference and the effect on the listening environment. Possible explorations could include:

- Room Nodes
- Active Noise Cancellation

Figure 3.16: Appendix 1 p.24

Forming the backbone of Music Technology, the science of sound is an important topic to cover. This can be taught practically through the use of models and practical experimentation, due to the focus on acoustic exploration. The content covered clearly links to the Science portion of the tetrad, but also to the Technology portion as so much of our daily interaction with sound is through code and programs.

Psychoacoustics
This module aims to inform the student about how we hear and the importance of understanding the mechanics and possible hindrances an engineer could experience in practice. This includes the study areas of:

- Anatomy of the Ear
- Stereo Localisation
- Psychoacoustic Phenomena

Anatomy of the Ear should focus around the theoretical concepts and functions of each section of the ear, this aims to inform the student of the inner workings of how we experience the medium. Possible areas of interest could include:

- The Pinna
- Middle and Inner Ear
- Critical Bands

Stereo Localisation should focus on the way humans perceive direction with regard to sound. This could be done digitally or using practical examples. Possible applications or areas include:

- ITD and IED
- HRTFs
- Binaural

Psychoacoustic Phenomena should focus on illusions of sound, where we perceive a non-existent source or are blinded by another. Areas which could be covered are:

- Time and Frequency Masking
- Limits of Human Perception
- Auditory Illusions

Figure 3.17: Appendix 1 p.25

This module is designed to inform the student about the methods and mechanisms in which we are able to perceive the medium of sound. It is an important topic because understanding the mechanisms behind perception could allow choices to be influenced in the studio. Furthermore, testing the perception can better inform students on the pitfalls and successes of their own ears. This makes clear links to the Production and Science portion of the tetrad.

3.2.5 Software Decisions

Coding with Pure Data

The decision to specify the Purr-Data distribution opposed to vanilla or extended is due to the ease of operation for new users and the application to education. There are a few more distributions which were considered for this purpose.

pd-ceammc: This distribution was created for the Centre of electroacoustic music of Moscow Conservatory, although it offers a more advanced GUI featuring a toolbar for object placement and premade filters and oscillators, it still retains a lot of the original 'Vanilla' pure-data. This means that it inherits a lot of the downsides of vanilla's interface,

such as the lack of distinction between signal and audio I/O and a polished user interface with common commands such as CTRL+MouseWheel to zoom.

pd-next: This distribution features the ability to colour code certain patches and allows distinction between signal and audio I/O. However, it only builds these features on top of vanilla, meaning the source is still very similar and lacks the polished interface.

purr-data: This distribution is based off of Ico Bukvic's Pd-L2Ork a fork of Hans Christoph Steiner's Pd-extended, which itself is built off of the original Pd by Muller Puckette. This offers a cleaner and more informative GUI written in JavaScript and is fully cross-platform across Mac, Windows, and Linux. The GUI now features dynamic inlets and cable thickness to signal message or audio transmission.

Production with Reaper

Many DAWs exist on the market and a lot of them allow for a student to easily pick up the concepts of Music Technology. However, each DAW provides its own challenges when learning the interface and functionality. A few different DAWs could be used as a 'beginner' DAW, the reason for selecting a 'beginner' DAW is that there is no previous experience required to take part in the course. Due to the middle years program not offering a subject in Music Technology, it means that the barrier for entry should be low.

GarageBand: GarageBand is a basic DAW primarily focused on introducing users to the timeline workflow and making music. In later versions it is possible for use as a 'fully-fledged' DAW, however, it still does not retain the number of features offered in a 'professional' DAW. In addition to this, GarageBand is only offered on macOS devices, this would require the purchase of an Apple product such as an iMac or MacBook. Based on this alone, the inability for a student with a Windows laptop/desktop to download and use the software means that GarageBand would not be suited for this course.

Logic: Logic's most recent versions offer an interface very similar to GarageBand to allow a natural progression from a 'beginner' DAW to a 'professional' DAW. However, much like GarageBand, it is only available on macOS which disqualifies it from use due to accessibility. This is because if the student is expected to provide a laptop so that they can work on assignments at home, the price of entry should not be so high.

Ableton: Ableton's speciality comes in the form of performance. This DAW consists of two workflows, allowing for projects to be performed and converted to a live set quickly and easily. The disadvantage for this DAW is the price of entry, although there is the offer for a 'lite' and 'standard' variation, the best offering is the 'suite' as it gives you the ability to use 'Max for Live' which is a programming language similar to Pure Data. Due to the decision to use opensource or lower priced software to allow for the barrier of entry to be lowered, this means Ableton is too expensive to use on a course wide basis.

Pro-Tools: Pro-Tools is seen as the 'industry standard' however, due to this it requires a lot of training in order to operate. This is because Avid does not offer tools to rebind commands. In addition to this, Avid has moved from a purchase method to a rent method, this means a monthly fee in order to use Pro-Tools. Once again, the barrier for entry is

too high, as it would be unethical to expect someone with no prior knowledge to enter the course and pay additional charges if the student wished to pursue the DAW at home on a personal computer.

Reaper: The argument for Reaper is that it offers an interface which can be quickly taught and highly customisable to fit certain needs. In addition to this, the JSFX language can offer an opportunity to learn about coding in music technology. The product is cheaper for a personal licence and offers a very generous upgrade path. It was created due to the growing price in DAWs and is constantly updated.

3.3 How should it be assessed?

Each assessment is written to reflect a potential assignment which would be required by a practitioner in that field. It is meant to be a project or problem based assessment where the student is given the opportunity to put into practice what has been taught. Many processes in these assessments will mirror or follow classroom activities, however, this time there will be little guidance from the educator. There is an important distinction that the assessments will alter from higher level to standard level. This means that the content taught may differ, most learning of the material is dedicated to practical time, so it is expected that the assessments would require a higher standard.

3.3.1 Assessment Breakdown

The Bedroom Producer

Purpose:

This assignment asks the student to display musical knowledge along with technical knowledge about the workings of a DAW by composing and producing a song using synths, samplers, and DAW based effects. Use of recording may only be done to add vocals. There will then be a short report discussing the process of writing and mixing the song.

Song Requirements:

- (HL) Two pieces of music in different styles
- (SL) One piece of music
- Length of at least 3 minutes
- Use of at least 4 synthesised tracks and 4 sampled tracks
- Use of mixing techniques

Report Requirements:

- Context: Background information on the intent of your piece of music in addition to the genre of music you've chosen. This should be accompanied by a short history of electronic music.
- Composition: A small section referencing the reasons why the piece of music works theoretically, in addition to why certain decisions were made during the piece's creation.
- Synths: Description as to the methods of synthesis you chose and why they are relevant to the music is made. This should be accompanied by any samples that were used, along with why they have been used.
- Mixing: Description of mixing techniques used and justifications for why they were done.
- Evaluation: This section gives the student an opportunity to reflect on:
  - Whether the song sounds good or not
  - If the song fits the brief and the genre, they selected
  - Where the song fails to meet expectation
  - What to change next time

Figure 3.18: Appendix 1 p. 28

This module is assessed through the creation of music. The main areas which this assessment would address on the 'Tetrad of Music Technology' are production and art, as composition and fidelity of sound are the focus. The primary taxonomy objectives covered in this is the evaluation of one's own work in the context of electronic music and the creation of new elements using knowledge previously obtained through analysis of electronic music.

Record Production

Purpose:

This assignment asks the student to display their studio knowledge and ability to work as a team to record a band. This will be done through recording a song with various instruments and mixing it into a well-rounded, clear, and dynamic recording.

Song Requirements:

- (HL) Two pieces of music in different styles
- (SL) One piece of music
- Length of at least 3 minutes
- Use of at least 4 instruments, which must include:
  - Drum Kit
  - Guitar
  - Vocals
- Use of at least 4 microphones on the Drum Kit
- Use of mixing techniques

Report Requirements:

- Context: Background information on the intent of your piece of music in addition to the genre of music you've chosen. This should be accompanied by a short history of the recording process.
- Recording: Description of the microphone and techniques used and justifications for why they were done. This should include the names and polar patterns of any microphones used, in addition to any techniques.
- Mixing: Description of mixing techniques used and justifications for why they were done. This should include any in the box or outboard gear and a description of the routing in the studio.
- Evaluation: This section gives the student an opportunity to reflect on:
  - Whether the song sounds good or not
  - If the process of recording worked well
  - If time management skills are important for this job
  - What obstacles were encountered.

Figure 3.19: Appendix 1 p. 29

This module is assessed through the production of someone else's music, this means that the student can detach from the arts links and simply focus on the technology of audio engineer and the production of mixing and mastering. The primary taxonomy objectives focused on in this module are understanding the source material from the artist and applying that knowledge to aesthetic choices in sound direction. It also requires the analysis of certain aesthetics and the evaluation of ones own recreation of it.

Performance and Live Electronics

Purpose:

This assignment asks the student to display their practical knowledge of performance. They are expected to use Music Technology in some way to perform in a concert environment. The student will then reflect and write about their preparation and performance in a short report.

Performance Requirements:

A student may choose to utilise various technologies in the performance, this could take inspiration from laptop ensembles, midi controllers or standalone units. The performance should be an exploration for the possibilities and sonic diversity which comes from music technology, it allows the student to study and perform genres which they enjoy. The SL performance must be at least three minutes long, the HL performance must be comprised of at least seven minutes split into one or two pieces.

Performance Merit:

- How extensively the use of Music Technology meets the musical material.
- The depth of which the student engages with their technology.
- How well communication to the audience is during the performance.
- How well understood the equipment is.

Report Requirements:

A 2–4-page technical report displaying your accomplishments (including diagrams). This report should include the following:

- Context: Background information of performance using live electronics, with reference to historical performances and pioneers in the field.
- The Piece: A short section on how the piece was constructed, either composed or arranged for the instruments you chose.
- The Performance: A section on the performance and what was chosen to be emphasised, any performance markings or score.
- Evaluation: This gives the student the opportunity to reflect on the performance. How well the audience enjoyed it and how it could be better.

Figure 3.20: Appendix 1 p. 30

This assessment is evaluated through the performance or support role in a performance. This requires collaboration in the areas of technology, production and art. This is due to the different role's which a student may wish to take during the performance. The primary taxonomy objectives which a student will use are analysis of the art of performance and engagement, the application of material and knowledge in live mixing and the creation of a new performance every time.

Pure Data and Synthesis Design

Purpose:

This assignment asks the student to display their understanding of synthesis techniques by creating a Pure Data patch containing two different synthesisers for SL and three for HL. These should be played using a sequencer built within the patch. The student will review their decisions in a short technical report.

Patch Requirements:

A successful patch should contain:

- Sub-patches for each of the two synthesis techniques used.
- Use of GUI elements to control the synthesisers and change parameters.
- A pre-sequenced audio demonstration of the potential of the synthesis system.

The two synthesisers must contrast in the approach to synthesis, as an example of this is:

- Subtractive and Frequency Modulation
- Frequency Modulation and Wavetable
- Additive and Granular

Report Requirements:

A 2–4-page technical report displaying your accomplishments (including diagrams). This report should include the following:

- Context: Background information regarding the development of the selected synthesis method and any historical context as to why it was developed or used.
- Theory: This should explain how the synthesisers work and why they create the sounds that they do.
- Design: This section should make specific references to portions of the patch and how they directly link to the theory. The motivation for the project and design should also be described, along with the application to music creation and production.
- Evaluation: This section gives the student an opportunity to reflect on:
  - How well each synth worked sonically
  - The user-friendliness of the synth
  - The limits of the synth method

Figure 3.21: Appendix 1 p. 31

This module is evaluated through the production and creation of a synthesis system inside a PD patch. It is aimed towards the science and technology sectors of the 'Tetrad of Music Technology', the objectives which a student will use are primarily analysis of current synthesis systems and application of the knowledge gained from this analysis.

20th Century Music

Purpose:

This assessment allows the student to display knowledge of the 20th century and their understanding of the techniques and compositional styles used throughout Western Art Music. This will be done by a comparative essay where two pieces will be chosen and analysed, allowing for an exploration of the musical elements.

Essay Requirements:

This 2000-word essay should focus on the ability to identify musical elements and their use in a contemporary composition. This is to be a comparison between two pieces from two different areas taught within the module, examples of valid essays are:

- Popular Recorded Music and Early Electronic Music
- Contemporary Classical and Popular Recorded Music
- Early Electronic Music and Contemporary Classical

Essay Merit:

This will be marked according to criteria set below:

- Identified pieces and areas of the 20th Century.
- Analysis and Comparison of the Musical Elements
- Music Terminology
- Understanding and Creativity
- Links to further investigation or evidence

Figure 3.22: Appendix 1 p. 32

This module is assessed through the creation of a piece of music in the style of a 20th century method of composition. This is primarily situated within the art component of the 'Tetrad of Music Technology'. The objectives which this assessment asks a student to display are analysis of a piece of music, evaluation of the pros and cons of each element and how it is used within the piece. Then create, taking the previously learned knowledge and applying it to a new knowledge in the form of music.

Electro-Acoustic Composition

Purpose:

This assessment asks the student to present their musical ability when creating a 3–5-minute composition utilising methods from study in the 20th Century module. This will be accompanied by a 300 word commentary.

Composition Requirements:

The piece of music is expected to meet the following criteria:

- 3-5 minutes in length
- use of at least 2 different compositional techniques or styles
- may use a form of experimental notation
- may use of multiple sources to convey movement

Commentary Requirements:

The commentary should follow a format similar to the following:

- Introduction
- Background
- Compositional Style
- Any prerequisite knowledge required to play the piece
- A key if experimental notation was used

Figure 3.23: Appendix 1 p. 33

This module is assessed through the creation of an electro-acoustic composition combining the technology, science and art to form a combination of all three. During this assessment, students will engage with the application of learned knowledge and analysis of other art forms. This will also lead to the deeper evaluation and creation of new forms of art.

Psychoacoustics

Purpose:

This assessment allows the student to display knowledge of the anatomy and the understanding of how we perceive the world around us. This will be done by designing an experiment to test the perception of the human ear, with a Pure Data patch to create the phenomena to a test subject. They will then display their knowledge, discussing the theoretical and physical in a short report.

Test Requirements:

The test should be capable of being taken without supervision of the author. This means that a user-friendly interface should allow a subject to setup, test and collect the data to make conclusions about the workings of the ear/brain. Psychoacoustic phenomenon which could be investigated are:

- The phon scale
- Pitch illusion
- Minimum number of cycles to detect pitch
- Tuning system preferences for music listening
- IID and ITF trade-off
- Forward/Backward Masking
- Critical Bands
- Binaural beats

Pure Data Patch Requirements:

- Clear demonstration of the chosen psychoacoustic phenomenon.
- User-friendly GUI allowing for the test to be taken unsupervised.
- Patch should be self-documenting and well commended.

Report Requirements:

A 2–4-page technical report displaying your accomplishments (including diagrams). This report should include the following:

- Context: Background information regarding the history of the Psychoacoustic Phenomenon and the theories surrounding it's perception.
- Experiment Design: Detailed explanation of synthesis and the testing methodology.
- Results: An indication of expected listening results along with any preliminary results which have been collected successfully.
- Evaluation: This section gives the student an opportunity to reflect on:
  - how well the listening test adhered to the aim
  - the user-friendliness of the listening test
  - the limits of the testing methodology

Figure 3.24: Appendix 1 p. 34

This module is assessed through displaying a potential experiment to test the human perception. Asking the student to combine science and technology in order to evaluate decisions in production, which then display themselves in art. Primarily focused on the understanding of the human anatomy, analysis of what is perceptual and the creation of

an experiment to test your understanding.

3.4 Learning activities

3.4.1 How to write activity sheets

The activity sheets were written from the perspective of a teacher not being present. In this case, the teacher could engage with the work sheet to a degree that they see fit. This means that the sheets could work with a less knowledgeable or substitute teacher if need be. They are written in a style as to guide the student through step by step, allowing for knowledge to be recapped along with additional tasks if a student finishes the sheet.

As referenced earlier, Bloom's taxonomy of educational objectives was taken into account when creating these activities. Allowing the student to work through the acquisition of knowledge and the understanding of application.

The visual style was made to give clear instructions (highlighted blue) and explanations (boxed orange). This means that if a student were to rerun the worksheet they would be able to comprehend exactly the parts which they wanted. Splitting down the worksheet into aims or goals oppose to one big sheet means that a sense of accomplishment comes at regular intervals and key stages in the learning process. The reflection points and summery add to this, allowing a moment of thought to reflect on the steps which were taken to get there. This style fits into the IB's method of teaching through reflection and allowing specific time to see what went well, and what could be improved.

3.4.2 Reactions to the activity sheets

Testing the activity sheets were completed with peers and people who had little to no experience with music technology, this would best model the type of student which the course would cater for. This was done in a very limited variety to check for errors or areas which were missing. The important concept to take from this is not the effectiveness of the worksheet in teaching, but primarily the flow and pace of the worksheet. This would inform choices in writing and allow adaptation to different styles.

The test subject would be sat down with a computer pre-installed with both Purr-Data and Reaper and told to work through the activity. This was done under less-than-ideal conditions as typically a teacher would be demonstrating and working through the sheet with the students, however, this test was done without help unless prompted to see if the format and support offered on the activity sheet was descriptive enough to achieve the end goal. This is in the case that a lesson is done without a knowledgeable educator, such as a substitute teacher.

The Purr-Data worksheet evaluation showed that people with little to no knowledge in programming or music were able to navigate the interface with a small amount of input from the supervisor. However, there were small sections where explicit instruction or extra context as to why you would perform an action would have been helpful to further develop the ability to retain the knowledge presented. From the small set of people which ran through the sheet, it was clear that the instructions were sufficient with some direction from the educator. This, however, does not explore how the activity would be scaled to a classroom of 20-30 students. It is expected that in smaller classrooms where the subject usually resides, error checking would not be as difficult. Due to the nature of open-source

programs, support would be difficult if outside the bounds of the educator's knowledge and specialities.

Regularly during the author's personal experience at undergraduate, there was rarely a member of staff who was able to provide support on all programs. This caused the modules to be assigned on familiarity to the source material. In a sixth form college where the proposed IB course would be situated, the department to teach 'Music Technology' would often be comprised of a small team. The choice to make Purr-Data the primary programming language means that support for both educators and students is much easier and less stressful.

Chapter 4

Reflection

Often throughout a longer-term project, there are things that you learn about how one works. These can range from time management to research methods to even the daily schedule, many of which change constantly as a project develops.

4.1 The Product

The final syllabus uses a lot of standardised sections from other IB Guides, this means that not all the sections presented is work from the author. However, a list of sections contributed to is listed below.

- 1.3 Technical Requirements for this course
- 1.4 Nature of the subject
- 1.5.1 Music Technology and theory of knowledge (examples only)
- 1.5.2 Music Technology and creativity, activity, service (examples only)
- 1.5.3 Music Technology and the extended essay (examples only)
- 1.5.7 Links to the Middle Years Programme
- 1.6.1 Approaches to teaching in Music Technology
- 1.6.2 The Production Journal
- 1.7 Aims
- 1.8 Assessment Objectives
- 2 Syllabus
- 3.2 Assessment outline - SL and HL
- 3.3 Module Assessment

Upon reflections, the structure of the product stands alone, along with integrating itself into the directory of other subjects offered by the IB. The author believes that using and displaying other guides to shape the form of this one is a considerable advantage. If not given the ability to do so, one would have had to look into how technical documentation of different standards are presented. Sadly, it was not possible to obtain or replicate the graphic used at the top of headers, though this would not have added any content it would have vastly improved the believability that the product really does exist.

The author feels that the content included in the course suggested, equally represents each portion of the theorised 'Tetrad of Music Technology', and that the teaching style and assessment fit the vocational style of the course aimed for. The idea of putting a focus on the science and technology side of the course means that the course does not simply

cater to the recording engineer position.

After seeking guidance from the author's former IB coordinator, he commented that the syllabus written was 'part justification and part instructional.' This justification is usually designated to review documents rather than the guide. He mentioned that if the guide were to be implemented there would need to be minor tweaks to alter the focus. However, the overall impression was positive.

This change in focus could be due to the nature of this report. The author is attempting to justify why and how the IBO could implement the syllabus into the IB DP. This may have resulted in the syllabus reflecting the justificatory style, as opposed to the purely instructional of other guides. Should this guide be perused further, changing the style would be an important step in bringing the guide in line with other IBO subject guides.

4.2 Challenges

Throughout the process of researching, creating, and evaluating there were many hurdles which had to be overcome.

At one point in the project, the author was contacted by the IB regarding the intention of the project and how one would go about conducting research. This was concerning, as the possibility of the IB not supporting the project was present. However, the IB emailed back with resources on creating a syllabus, this served as fuel to persist as the project was not going to be shut down due to the project topic.

Due to the changing landscape with bedroom production booming in the 2000s and 2010s, it was difficult to rein in exactly what was required for this section. From personal experience, it was noticed that a lot of the development of the production skills were simply linked to the amount of time and exposure that one spends with the tools. This meant that the 'Bedroom Producer' module was to be situated at the start of the course to allow for the most time for the skills to be developed.

4.3 Time Management

Time management has been a challenge throughout the author's academic career. Despite attempting many methods of time management such as to-do lists, bullet journal, and work blocks, keeping upto date was challenging. Often as a result the techniques would become so far out of date that they were disregarded in favour of new methods. Despite this, deadlines are often met or exceeded, allowing for more time to reflect and check. However, due to the flexible nature of this project, it meant that working to a strict schedule proved difficult.

4.3.1 Gantt Chart

Despite the apprehension to time management as previous projects were successfully conducted in a time sensitive manner, excitement to experiment with Gantt Charts was a primary focus. The author thought that the structure would afford greater control and progress with the time given. However, access to a well-crafted Gantt Chart tool for free was a sizeable roadblock, it meant that time, put into the project, was instead put into finding good software. Although an open-source free program was found, it featured a dated interface with unintuitive controls and required a large learning curve to work with effectively.

After inputting the data into the chart, their was a hesitancy to change any entries, as the system was not familiar or intuitive. As a result, the author actively avoided using it, despite the time already invested into it. In addition to this, due to working a schedule around other's, it meant that a lot of the dates would change day by day. As a result, simply setting a goal for the end of the day or week proved simpler and more effective. This prompted managing time on a macro scale oppose to a micro scale.

Unfortunately, it was only after completing the majority of the project that the author was informed of the piece of software one was looking for all that time. Although, this was irritating, it has started to be implemented into another personal project. Due to the easier interface and collaborative feature, it has been easier to keep updated. This is due to the collaborative nature of the project and having to stay updated with the rest of the team. Despite being unable to keep a Gantt Chart going throughout the project, the techniques of compartmentalisation will be used in future projects.

4.4 Outcomes

The initial aims and objectives for the project were:

Aim: Develop a syllabus for the subject of Music Technology, utilising the format and key concepts of the International Baccalaureate.

- IB
  - Evaluate the similarities and differences between international qualifications.
  - Evaluate the key concepts of the IB and observe how the skills of 'Music Technology' relate.
  - Evaluate and replicate the style and context of IB subject guides/briefs.
- Pedagogy
  - Evaluate hardware and hands on control enhance the overall attachment and engagement of a subject.
  - Evaluate the role of creating ones own technology and how the creativity and problem solving can enhance learning and retention.
  - Find a balance between the role of the teacher and independent study.
- Subject
  - Develop/Research a robust definition for the subject of 'Music Technology'.
  - Create 2-3 lesson plans ready to be deployed.
  - Evaluate the skills required for 'Music Technology' and develop a hierarchy for prioritisation.

The 'IB' and 'Subject' objectives appear to have been met, but when attempting to complete the 'Pedagogy' objectives, the author failed to evaluate how hands on control enhances learning and engagement. The objective of problem-solving was only half answered and the balance objective was taken from the current music course with adjustments. It is believed that tangible evidence is present for the completion of the other objectives. The Aim was completed in a way which is formatted and adherers to the key concepts of the IB.

4.5 Further Research

Further research in this area could be aimed towards the implementation of the course into the IB, or structure it differently to create another course simply in an education standard. Adding or subtracting from this course could be a good template for a university course or a limited diploma in 'Music Technology'. This course was written to allow direct access to industry work and further education.

Due to the idea that specific subjects should be taught in a specific way, additional research could be into the specific techniques utilised in classrooms of multi-style courses. This would entail a practical experiment testing knowledge retention within both a studio environment and the classroom to test the role of practical teaching.

Further more, because of the subjective nature of mixing practice it would be interesting to research the act of teaching specific techniques which a practitioner uses in the studio. This is because often, the techniques were developed along with the practitioner. Teaching these techniques could lead to quicker results, but less experimentation as what the educator does is often seen as the right way.

Chapter 5

References

[1] C. Boehm, 'The discipline that never was: Current developments in music technology in higher education in britain,' *Journal of Music, Technology and Education*, vol. 1, no. 1, pp. 7–21, Nov. 2007. DOI: 10.1386/jmte.1.1.7_1.

[2] F. J. Rees, 'Redefining music technology in the united states,' *Journal of Music, Technology and Education*, vol. 4, no. 2, pp. 149–155, Feb. 2012. DOI: 10.1386/jmte.4.2-3.149_1.

[3] F. Rumsey and T. McCormick, *Sound and recording*. Amsterdam London: Elsevier/Focal, 2009, p. 168, ISBN: 0240521633.

[4] C. Boehm, R. Hepworth-Sawyer, N. Hughes and D. Ziemba, 'The discipline that 'became': Developments in music technology in british higher education between 2007 and 2018,' *Journal of Music, Technology & Education*, vol. 11, no. 3, pp. 251–267, Dec. 2018. DOI: 10.1386/jmte.11.3.251_1.

[5] D. Moore, 'Supporting students in music technology higher education to learn computer programming,' *Journal of Music, Technology and Education*, vol. 7, no. 1, pp. 75–92, May 2014. DOI: 10.1386/jmte.7.1.75_1.

[6] A. Moore and D. Moore, 'Adapting to change: Working with digital sound using open source software in a teaching and learning environment,' *Body, Space & Technology*, vol. 7, no. 2, Jul. 2008. DOI: 10.16995/bst.140.

[7] H. Roels, 'Abunch, a tool to teach live electronics in pre-college music education,' *Journal of Music, Technology and Education*, vol. 5, no. 2, pp. 181–193, Oct. 2012. DOI: 10.1386/jmte.5.2.181_1.

[8] G. Wang and Stanford Laptop Orchestra. (2013). 'Twilight.' Accessed: 08/07/2021, [Online]. Available: https://www.youtube.com/watch?v=chA-4GRCb-I.

[9] T. Mudd, 'Developing transferable skills through engagement with higher education laptop ensembles,' *Journal of Music, Technology and Education*, vol. 5, no. 1, pp. 29–41, May 2012. DOI: 10.1386/jmte.5.1.29_1.

[10] N. Collins, 'Live coding and teaching SuperCollider,' *Journal of Music, Technology and Education*, vol. 9, no. 1, pp. 5–16, May 2016. DOI: 10.1386/jmte.9.1.5_1.

[11] Oxford English Dictionary. (2021). 'Pedagogy.' Accessed: 07/07/2021, [Online]. Available: https://www.oed.com/viewdictionaryentry/Entry/139520.

[12] N. Huse and N.-T. Le, 'The formal models for the socratic method,' in *Advanced Computational Methods for Knowledge Engineering*, Springer International Publishing, 2016, pp. 181–193. DOI: 10.1007/978-3-319-38884-7_14.

[13] Waves Audio Ltd. (). 'Waves c1 compressor.' Accessed: 12/06/21, [Online]. Available: https://www.waves.com/plugins/c1-compressor.

[14] International Baccalaureate Organisation. (2021). 'Education programs.' Accessed: 12/06/21, [Online]. Available: https://www.ibo.org/programmes/.

[15] ——, (2021). 'Why the ib is different.' Accessed: 12/06/21, [Online]. Available: https://www.ibo.org/benefits/why-the-ib-is-different/.

[16] ——, (2021). 'Theory of knowledge.' Accessed: 12/06/21, [Online]. Available: https://www.ibo.org/programmes/diploma-programme/curriculum/theory-of-knowledge/.

[17] ——, (2021). 'Extended essay.' Accessed: 12/06/21, [Online]. Available: https://www.ibo.org/programmes/diploma-programme/curriculum/extended-essay/.

[18] ——, (2021). 'Cas projects.' Accessed: 12/06/21, [Online]. Available: https://www.ibo.org/programmes/diploma-programme/curriculum/creativity-activity-and-service/cas-projects/.

[19] ——, (2014). 'A guide to curriculum development.' Accessed: 12/06/21, [Online]. Available: https://www.ibo.org/globalassets/publications/guide-to-dp-curriculum-development-en.pdf.

[20] ——, (2016). 'Dp music curriculum development.' Accessed: 12/06/21, Restricted Access.

[21] ——, (2019). 'Dp music curriculum review.' Accessed: 12/06/21, Restricted Access.

[22] ——, (2020). 'Music guide: First assessment 2022.' Accessed: 12/06/21, [Online]. Available: https://erhs.la/sites/default/files/global/music_guide_2022.pdf.

[23] Native Instruments. (2013). 'Battery 4.' Accessed: 12/06/21, [Online]. Available: https://www.native-instruments.com/en/products/komplete/drums/battery-4/.

[24] ——, (2018). 'Kontakt 6.' Accessed: 12/06/2021, [Online]. Available: https://www.native-instruments.com/en/products/komplete/samplers/kontakt-6/.

[25] International Baccalaureate Organisation. (2021). 'Additional subjects.' Accessed: 12/06/21, [Online]. Available: https://www.ibo.org/programmes/diploma-programme/curriculum/additional-subjects/.

[26] ——, (2017). 'Food science and technology guide: School-based syllabus.' Accessed: 12/06/21, [Online]. Available: https://island.edu.hk/wp-content/uploads/2015/09/Food-science-and-technology-guide-first-assessment-2019-1-2.pdf.

[27] P. Edexcel. (2017). 'A level music technology specification.' Accessed: 12/06/21, [Online]. Available: https://qualifications.pearson.com/content/dam/pdf/A%20Level/Music-Technology/2017/specification-and-sample-assessments/9781446933329_GCE2017_AL_MusicTech_Spec.pdf.

[28] B. Bloom, *Taxonomy of educational objectives : the classification of educational goals*. New York: David McKay Company, 1956, ISBN: 9780582323865.

[29] J. A. Bowen and C. E. Watson, *Teaching Naked Techniques*. John Wiley & Sons Inc, Feb. 2017, 272 pp., ISBN: 1119136113. [Online]. Available: https://www.ebook.de/de/product/27990517%20jos_antonio_bowen_c_edward_watson_teaching_naked_techniques.html.

[30] S. Boss, *Implementing Project-Based Learning*. SOLUTION TREE, Apr. 2015, 80 pp., ISBN: 1942496117. [Online]. Available: https://www.ebook.de/de/product/24133053/suze_boss_implementing_project_based_learning.html.

[31] E. Crawley, 'Creating the CDIO syllabus, a universal template for engineering education,' in *32nd Annual Frontiers in Education*, IEEE. DOI: 10.1109/fie.2002.1158202.

[32] University of Sussex. (2021). 'Music Technology BA (Hons).' Accessed: 03/09/2021, [Online]. Available: https://www.sussex.ac.uk/study/undergraduate/courses/music-technology-ba.

[33] University of Winchester. (2021). 'BA (Hons) Music and Sound Production.' Accessed: 03/09/2021, [Online]. Available: https://www.winchester.ac.uk/study/undergraduate/courses/ba-hons-music-and-sound-production/.

[34] Glasgow Calendonian University. (2021). 'BSc (Hons) Audio Technology.' Accessed: 03/09/2021, [Online]. Available: https://www.gcu.ac.uk/study/courses/details/index.php/P03156/Audio_Technology/.

[35] University of Kent. (2021). 'Music Technology and Audio Production BSc (Hons).' Accessed: 03/09/2021, [Online]. Available: https://www.kent.ac.uk/courses/undergraduate/2503/music-technology-audio-production.

[36] Bournemouth University. (2021). 'BA (Hons) Music and Sound Production.' Accessed: 03/09/2021, [Online]. Available: https://www.bournemouth.ac.uk/study/courses/ba-hons-music-sound-production.

[37] University of York. (2021). 'Music and Sound Recording BA (Hons).' Accessed: 03/09/2021, [Online]. Available: https://www.york.ac.uk/study/undergraduate/courses/ba-music-sound-recording/#course-content.

Chapter 6

Appendices

- **Appendix 1: Music Technology IB Proposed Guide**
  This document is meant to mimic the style of guide which the IB displays on their website for each subject.
- **Appendix 2: Activity 1 - Teaching Synthesis with Purr**
  This document is an activity focusing on the creation of synthesis through Purr-Data. It is designed to be part of the 'Pure-Data and Synthesis Design'.
- **Appendix 3: Activity 2 - Teaching Production with Reaper**
  This document is an activity focused on introducing Reaper as part of the 'Bedroom Production' module.