Complementing students' classroom curriculum – part two

Edward Maxwell

Introduction

Some class teachers and parents fear that, in coming out of class lessons for their instrumental tuition, children may be missing out on important academic material. These are completely legitimate concerns that need to be addressed with understanding and sympathy. There is a wealth of studies that seem to unequivocally indicate that children who take music lessons outperform their peers academically. Sometimes, looking at an issue from a musical perspective can help to unlock understanding in other areas.

In part one of this two-part resource (*Music Teacher*, **June 2024**), we looked at finding links with other subjects in our instrumental teaching. Part two is a continuation of our tour of the school curriculum. As with part one, some of the examples below are taken from my own experiences as a trumpet player, but please adapt the ideas to your own instrument.

Maths

Maths is the study of numbers, shapes, measurements, patterns, codes and symbols, and music has all of these in abundance. Musical notation is itself a code – the score of any piece of music contains *all* the information required to bring it to life. The performer just needs to learn how to decode it. Let's start with the basics of rhythm and pitch.

Rhythm

When playing a rhythm, we're *dividing* time, while simultaneously *counting* beats in a bar.

- A piece may have a metronome marking that indicates how fast the underlying pulse is, in beats per minute. If a piece in 4/4 at 120bpm changes into 6/8 time, but the quavers stay at the same speed, what will our metronome setting be for a dotted crotchet? (The answer is 80. The speed of a quaver is 240bpm; divide this by 3 to get the speed of a dotted crotchet.)
- Rhythms are all about ratios as well as speed. A minim followed by two crotchets at a metronome speed of 120 gives an identical rhythm to a crotchet followed by two quavers with our metronome at 60. Can your student write a rhythm using double or half the lengths of the notes?
- The time signature is essentially a fraction: the top number tells us how many 'units' there are in a bar; the bottom number is a code that represents the unit we're counting – this is derived from fractions of a semibreve. If you use the American system of 'whole notes' (semibreves), 'half notes' (minims), 'quarter notes' (crotchets) and 'eighth notes' (quavers), this system makes perfect sense. The time signature – or fraction – 4/4 means four 'quarter notes' in a bar, thus adding up to a 'whole note'.
- A bar can be divided into an infinite number of rhythms, but it always needs to add up to the number of beats in the bar. Try playing adding and subtracting games with your students – for example: you have a minim, a crotchet and a quaver in a bar of 4/4. What do you need to add to make a full bar?

A student will often not even realise that they're processing all this maths. Sometimes, however, a music lesson can become overtly mathematical – if, for example, you're teaching dotted rhythms. How long is a dotted minim, if the dot adds on half as much again? (Students will often mistakenly say two and a half.) Now apply the same process to a dotted crotchet. Then to a dotted quaver.

An astute student may ask: 'If we have a dotted crotchet/quaver rhythm at the start of a bar, why is the quaver *after* the second beat, when the first note is only a beat and a half?' And the answer is, of course, because we start counting on one, not zero. When we're born, we get to our first birthday after a year. In music, we *start* on one, so when we get to two, we've only had one beat.

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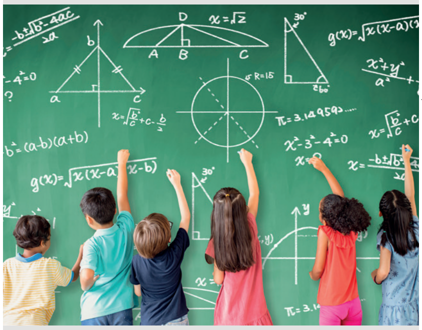
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Counting bars' rest

If you're a brass player, you'll spend much of your life counting bars' rest, rather than actually playing. Sometimes you have to do some quick mental arithmetic in a rehearsal when the conductor says, 'We'll go from bar 321' – which happens to be somewhere in the middle of 49 bars' rest that started at bar 298. Your next entry is at bar 347. How many bars do you need to count? (Actually, you just need to count 26 bars, which is 347 minus 321. The bit about the 49 bars starting at bar 298 was a red herring, but you can sometimes be overwhelmed with numbers and need to apply logic to determine what's relevant.)

Pitch

We encounter more numbers when looking at pitch. A melody makes musical *shapes* and *patterns*, using different intervals (the gaps between the pitches).

An octave is divided into 12 semitones. Scales are made up of different patterns of tones and semitones (and an augmented 2nd, in the case of a harmonic minor). We measure the intervals between notes by counting up. Like counting beats of the bar, we have the anomaly that when counting intervals, we start on one, not zero. That means that an octave is (obviously) an 8th, but oddly two octaves gives us a 15th, not a 16th, and three octaves gives us the interval of a 22nd. After the initial eight, we add seven for subsequent octaves.

When looking at the maths in music, we can go on to look at the patterns of key signatures, the cycle of 5ths, chords, harmony, modulations and so on.

Advanced maths

Some composers intentionally embed maths into their pieces. An analysis of Bach's *Musical Offering* or Bartók's *Music for Strings, Percussion and Celeste* can reveal structures based on the Fibonacci sequence. In Mozart's *The Magic Flute*, the number three, an important Masonic number, permeates the work on many different levels.

An investigation of the history of the tuning systems we use involves some advanced calculations about ratios. Today, 'equal temperament' is the norm, but many early musicians playing 'period instruments' use subtly different systems, such as the Pythagorean system. This uses ratios to describe 'pure' intervals. Although attributed to Pythagoras, it's thought to predate Ancient Greece. In fact, equal temperament was not widely adopted until the late 18th and early 19th centuries. It's something of a compromise, allowing the ability to play in all keys, but with the added quality of being ever so slightly 'out of tune'. The maths behind it is fascinating.

If a child was taken out of a class maths lesson for an individual session on any of the above, would anyone still complain? Sometimes musical maths may just click for them, where class maths doesn't.

Science

The obvious starting point is the science of sound, which covers not only the physics of sound waves, but also the biology of how our ears receive sound and how the brain interprets it. All musical instruments need something to vibrate to make an initial sound, as well as a space for that sound to resonate and amplify.

What vibrates to make a sound on each instrument?

- Strings can be plucked, bowed or hit.
- Percussion instruments are struck with sticks, mallets or hands.
- Wind instruments have a variety of methods to produce vibrations, including blowing through single or double reeds, vibrating the lips, or blowing across a hole to make an air column vibrate.

Sound waves

We measure sound waves in Hertz (abbreviated to Hz). The standard tuning system we use is A=440Hz. If we double the vibrations, the pitch will increase to 880Hz and the sound will go higher by an octave. The A an octave below our original is at 220Hz.

How do we change the vibrations (i.e. the frequency of the sound waves) in order to produce different pitches?

- Strings have two variables: the tension of the string, and its length, which is changed by stopping the string with the fingers at many different points.
- Brass instruments have similar variables: the tension of the lips and the length of the tubing. They also rely on playing different partials in the *harmonic series*, which warrants further investigation and involves some very complex mathematical formulae. It needs to be noted that the harmonic series

does not quite align with equal temperament, so trumpets are inherently slightly out of tune (or you might consider that trumpets, in adhering to the laws of maths and physics, are actually *in tune*, and it's the equal temperament system that's *out of tune*).

- For reed instruments, the two variables are the tension of the lips against the reed and the length of the instrument, which is changed by opening different holes.

Materials

The bodies of instruments, which amplify the vibrations, have different shapes and sizes and are constructed from different materials. These variables affect the overtones, which in turn affect the tone quality, known as timbre.

An examination of materials used to make instruments can lead us into some chemistry and biology, looking at different metal alloys, wood, animal skin or gut, or synthetic equivalents.

Chemistry

Brass is an alloy made from mixing two metals – copper and zinc. If these elements are mixed in different proportions, the brass will be slightly more yellow or red. 'Red brass', also known as 'rose brass', contains a higher copper content (90%) and gives a warmer tone quality, though the sound doesn't project as well. 'Yellow' brass has 70% copper and 30% zinc, giving a brighter and more direct sound.

If exposed to air, the metal will *oxidise*, giving it a tarnished look. To keep it shiny, the instrument is polished and then either lacquered or silver plated. The pieces of a brass instrument are soldered together and here, the melting points of different metals are crucial. Lead solder is used for many of the joints. This has a lower melting point than brass (obviously this is crucial – if the solder melted at the same temperature as brass, the entire trumpet would melt when you built it or did a repair, which wouldn't be ideal). But there remains the problem that if you want to remove, or indeed attach, one section, then other sections will fall off when you heat the trumpet up. This is mitigated to some extent by using silver solder on the more structurally important sections. This melts at a higher temperature than lead but a lower temperature than brass. The melting points are as follows: brass 930 degrees Celsius; silver solder 630 degrees; lead solder 188 degrees.

If you want to learn the periodic table, you might try learning the 'The Elements' by Tom Lehrer (to the tune of the 'Major-General's Song' from the *The Pirates of Penzance* by Gilbert and Sullivan), sung here by Daniel Radcliffe: **www.youtube.com/watch?v=rSAaiYKFocs**

Biology

A knowledge of the ways our bodies work is very relevant to operating musical instruments. You might, for example, consider how your muscles work when bowing or fingering, and your skeletal structure has a bearing on your posture when you play.

Vocal, wind and brass teachers will, at some stage, teach students how the diaphragm works. If you think back to your school biology lessons, you might remember using a bell jar and balloons to demonstrate the breathing process and the action of the diaphragm. We can utilise natural bodily processes when we play. Yawning is a good model for taking a deep breath, and if you play a short, loud, high note on the trumpet, the way you blow is similar to a cough.

Design Technology

DT covers the design and construction of different products. This might include technical drawing, the use of computers in design, and the study of different materials and their properties. The construction of different instruments obviously requires an extensive knowledge of traditional wood- and metal-working techniques, and how different tools work.

Here are some things you might consider:

- What materials are used to construct an instrument?
- Can substitutes be used (e.g. plastic or carbon fibre for traditionally wooden or metal instruments)?
- What tools do you need?
- What techniques are used?
- What's the difference between modern and traditional craft skills in instrument construction?
- Can you 3D print an instrument?
- Can you design and construct a working copy of an instrument?
- Can you invent your own instrument?

The tubing on brass instruments is made from sheet metal that's rolled up. Annealing the metal (heating up to a high temperature) will soften it, making it malleable and easier to work with, whereas hammering it will harden it. If you bend a metal tube it will crumple (like bending a straw). Traditionally, in order to bend brass tubing, it is filled with molten lead. When it is cooled, the brass can be bent without the tubing creasing. When the tubing is in the required shape, it's heated up and the lead removed. Mouthpieces would traditionally be made from turning a solid lump of metal on a lathe. These days, of course, much construction of instruments is done by computers and robots.

IT (Information Technology)

There's a crossover between IT lessons and class music lessons where computers are used for composing, notating and recording music. In instrumental lessons, students can be encouraged to use computers to:

- Find sheet music online that they'd like to play.
- Listen to recordings of music on YouTube or other platforms.
- Find backing tracks to play along to.
- Record themselves when they practise – it can be very instructive to critique their own playing.
- Use apps such as GarageBand to multitrack themselves.
- Use a notation programme to compose or arrange their own pieces.

Geography

In part one, we mentioned the ways in which language relates to music, and how composers have tried to assert a national identity in their music. You might also think of music that describes different geographical features. In Smetana's *Má vlast*, a set of six tone poems celebrating the Czech nation, the river Vltava is musically described (**www.youtube.com/watch?v=nuHpfGwgids**) from its source at two small springs to majestically flowing through Prague and finally joining the river Elbe.

Both the words and music of national anthems often give an insight into a nation's psyche. Although many national anthems are in rather generic Western classical music styles, you can hear hints of different countries' musical cultures. The Japanese national anthem (**www.youtube.com/watch?v=29FFHC2D12Q**), for example, has a pentatonic theme, the Indian anthem (**www.youtube.com/watch?v=HtMF973tXIY**) has the feel of a raga, and the Italian anthem (**www.youtube.com/watch?v=o4ckV9QueXc**) is very operatic in style, reflecting Italy's strong operatic tradition. Words are often militaristic, with the French anthem being particularly alarming, referring to cutting throats and watering fields with blood.

Physical education

As someone who loves sport, I've always been struck by the parallels between sport and music:

- We express ourselves using physical coordination, involving building up strength, balance and flexibility, and fine-tuning our motor skills.
- We need to manage physical demands, including building up stamina and learning to pace ourselves.
- We learn that physical repetition is crucial in developing skills, whether practising your backhand in tennis or playing scales in music.
- We learn about the importance of a warm-up and a warm-down.
- We learn about the functioning of muscles and our breathing processes (as mentioned in the section on biology).
- We have to perform in front of an audience.
- Some sports are individual, while others are played in teams. Similarly, music can be performed as a soloist or in an ensemble.
- We need to learn to recover and learn from the inevitable mistakes we will make.

Teamwork

When playing in a team – or in a musical ensemble – we need to be on the same wavelength as our colleagues. Professional sports players appear to have an almost telepathic awareness of their teammates. Footballer Kevin De Bruyne can thread the perfect pass to Erling Haaland without even apparently looking – he instinctively *knows* where he will be running. When playing ensemble music, we need to be alert to our colleagues and respond to the smallest details. This is most obvious when improvising, but even when playing notated music every performance needs to have a feeling of spontaneity – we listen and respond. Interestingly, when I've worked closely with a trumpet-playing friend, we've become so attuned to each other that as well as assimilating each other's musical gestures, we sometimes make identical and simultaneous mistakes.

Music in sport

Virtually every sport has an iconic theme tune, which students might love to play: Match of the Day (**www.youtube.com/watch?v=HiDgXAORsMM**); 'Soul Limbo' (the BBC cricket theme tune: **www.youtube.com/watch?v=67xXbTaQlKI**); 'Jupiter' from Holst's *The Planets* (rugby); Wimbledon (which interestingly has two themes – one at the start of the BBC coverage [**www.youtube.com/watch?v=Qm2jfSrrFkk**] and a different one at the end); Formula 1 (Fleetwood Mac's 'The Chain': **www.youtube.com/watch?v=oG6yyfwawBo**); snooker (**www.youtube.com/watch?v=7GkgoeKHsXI**); *Ski Sunday* (**www.youtube.com/watch?v=jOEO_fgG3-I**); and the list goes on. If you're old enough, you might even remember the uplifting themes to *Grandstand* (**www.youtube.com/watch?v=wSP1Eo4zp5Y**) and *Sportsnight* (**www.youtube.com/watch?v=Dxv6bDc7LQ4**).

In addition to the numerous songs sung on the terraces ('Sweet Caroline' by Neil Diamond, 1969, is a particularly popular example), football clubs have adopted an eclectic selection of songs as their anthems, such as:

- Liverpool: 'You'll Never Walk Alone' (from the 1945 musical *Carousel* by Rodgers and Hammerstein).
- Manchester City: 'Blue Moon' (by Rodgers and Hart, 1934).
- Manchester United: 'Glory, Glory Man United' (to the chorus of *Battle Hymn of the Republic*, written by Julia Ward Howe in 1861, during the American Civil War).
- Crystal Palace: 'Glad All Over' (by the Dave Clark Five, released 1963).
- West Ham: 'I'm Forever Blowing Bubbles' (by John William Kellette, 1919).

Business and careers

A report published by *UK Music* states that in 2022, 210,000 people worked in the music industry in the UK. It contributed £6.7 billion to the UK economy, and music exports generated £4 billion.

Jobs in music reflect working practices more generally. Interestingly, the term 'gig economy' is borrowed from music, where many of us freelance on an ad hoc basis. Musicians can be employed, self-employed, in a partnership or run a limited company. Employers can range from small independent businesses to corporate giants.

Careers in music can include:

- Performer
- Teacher
- Composer, arranger, editor
- Music librarian
- Concert administrator
- Publisher
- Examiner
- Agent
- Sound technician
- Music therapist
- Music journalist

Musicians usually have a patchwork career of several of these jobs (I do at least six on that list!).

PSHE (Personal, Social, Health and Economic education)

This subject covers general life skills and wellbeing, including citizenship, culture and diversity.

Music is a universal language, where we can celebrate both our similarities and our differences. Musical genres cross-fertilise, and we can enjoy playing, listening and dancing to music from all over the world without boundaries or borders. In doing so, we can develop an understanding of different cultures. Across the globe, music and dance is used to celebrate important events and rituals.

Listening to, and playing, music helps to promote:

- Compassion
- Cooperation
- Creativity
- Curiosity

- Calmness
- Confidence
- Empathy
- Emotion

Mindfulness

Many schools teach mindfulness, a meditative state that can improve our mental health. We try to clear our minds and focus on the present, without worrying about the past or future. We can strive to enjoy and appreciate the simpler things in life, such as nature and, of course, music. Not only the sort of structured music that we teach in our lessons, but also the sounds of our environment, such as birdsong, the sound of wind, rain or even the counterpoint of people's footsteps. John Cage's famous (or infamous, depending on your point of view) piece *4' 33"* (**www.youtube.com/watch?v=yoAbXwr3qkg**) was intended to alert the audience to the music of everyday ambient noise – not actually silence, but, as Cage explained, 'the absence of intended sounds'.

Conclusion

In our tour of the school curriculum, we've had a glimpse of the richness of music: how it can give us a unique perspective and enhance our knowledge and personal development in so many different ways. In learning music, students will grow academically, emotionally, creatively and spiritually. It's not always fun and can be incredibly frustrating, as any student stumbling over a tricky scale or attempting some 'impossible' sightreading will testify. But even in these circumstances, students will be developing problem-solving skills and learning patience and resilience.

We need to have the full support of parents and class teachers. One way of working together productively is to get a copy of students' school curriculum from their class teachers and find ways to weave elements of this into your instrumental lessons. In doing so, we will not only make our lessons more fun and interesting for our students, but also learn new things ourselves.