I Knew You Were Edwin Hubble

Good morning,

I love listening to and playing music. Playing music with my siblings and my youngest son is one of the greatest pleasures in my life. I would urge you all to include learning to play a musical instrument on your bucket lists, if you have not already done so. Playing in a band with my family has led to some of my favourite adventures, but those stories are for another day. Today's assembly is a bit about music and more about expanding on the theme of knowledge from last week and the interesting journeys and discoveries thinking about things you know can take you on.

When I find a new song I like, I have a habit of listening to it over and over and over. If a song strikes me I will listen to it loudly, on repeat for hours. I enjoy picking out my favourite parts, particular phrases and changes and drum fills and guitar riffs. I am told by members of my family this behaviour is irritating. Indeed, my recent obsession with the

Reel to Real's, I like to Move It caused my partner to express her irritation very firmly one recent Saturday morning.

You may be familiar with the Taylor Swift song I knew you were Trouble. This is a song I became obsessed with for a brief period of time a few years back. Now, despite my obsessive listening to songs I like, I rarely pay attention to many of the lyrics. I am usually hooked in by the melody and the rhythm. With apologies to Ms Swift, this was the case with I Knew You Were Trouble. I loved the rapid delivery of the verses, the whimsy pre-chorus and then the epic, anthemic chorus. But I still have no real idea what she was going on about. If you are a fan, perhaps you could let me know.

At that time I thought about the song a great deal, playing it back in my mind even when I wasn't listening to it. And, as you'll remember from last week thinking about something like this will get it to stick.

Anyway, I also love teaching physics. It happens at the same time as my obsession with Swifty began I was also teaching astronomy, which included a section on Edwin Hubble, and the Hubble Space Telescope. And my brain did a strange and wonderful thing and linked the great astronomer and the great pop star together, re-writing the unknown lyrics to I Knew You Were Trouble in the process:

I knew you were Edwin Hubble when you walked in
You found more galaxies now
You flew us to places we'd never been
And they're moving away now
Hubble hubble hubble....

Firstly, I believe this is one of the great joys of knowing things, and one of the reasons learning is amazing. When you know lots of stuff, you can call that stuff to mind whenever you wish, you can think about it all, and you can link bits of knowledge to other bits of knowledge. Sometimes this linking of pieces of knowledge can be daft, and for our

own amusement, and other times it can lead to new and profound understanding.

The latter happened to Edwin Hubble. I'll share a bit of his story and legacy. While listening to his story I'd like you to have in mind Douglas Adams's description of the size of the universe, because he undoubtedly had Hubble's story in mind when he wrote it.

"Space is big. Really big. I mean you just won't believe how vastly, hugely, mindbogglingly big it is"

Edwin Hubble was an astronomer one hundred years ago, during a time when humans had figured out our solar system was part of a huge cluster of stars and solar systems, numbering about 200-400 billion stars. Astronomers had called this type of cluster of stars a Galaxy, and they had named our galaxy The Milky Way. The story behind the name The Milky Way is an interesting one but for another day. Or for you to look up.

Scientists believed our galaxy was the whole universe. 200 billion stars and masses of empty space. One time Edwin Hubble was studying a photographic plate taken by the Hooker Space Telescope situated on Mt Wilson, California. He was initially interested in stars he labeled as Novae with a capital N. Nova in Latin means new. These Novae were new stars when compared to earlier pictures of the same patch of sky. A little later, and after a little more study Hubble realised one of the stars he'd labeled N wasn't a Novae at all, but a phenomenon called a Cepheid Variable. Cepheid Variables are stars whose luminosity varies. They appear to pulse bright and then dim as they spin on their axes. You can Google what is now known as the VAR plate and see for yourself Hubble's crossing out of the N, replacing with VAR!

While studying this Cepheid Variable Hubble made an important, profound, universe changing link between two bits of knowledge. His knowledge of Cepheid Variables, and Henrietta Leavitt's recently published technique to calculate the distance to a Variable star. Hubble

was curious to use Leavitt's technique to find the location of the Cepheid Variable. And the result was universe changing.

Hubble repeated the calculation, and every time he did the star was placed well over 2,000,000 light years away. This means if you were travelling at the speed of light, it would take you two million years to get there. This is far, far beyond the reaches of our own galaxy.

Remember, up to this moment, scientists believed The Milky Way Galaxy to be pretty much the entire universe. About 200 billion stars. And Hubble had discovered conclusive proof this was incorrect. Upon further investigation it became clear this Cepheid Variable was part of another galaxy, now named Andromeda. Andromeda Galaxy is, if anything, even larger than The Milky Way. The size of the universe doubled with Hubble's discovery. Hundreds of billions of previously unknown stars and solar systems, unimaginably distant.

Hubble went on to discover red shift, and demonstrate the universe is expanding. Hubble's legacy was to completely transform our understanding of the size and make-up of the universe, and our place in it, using his ability to link pieces of knowledge together.

This might seem to be a good ending. But, rather wonderfully, Hubble's story does not end there. Many years later, in 1990, a space telescope was launched, in order that it could take pictures of space without the pesky atmosphere getting in the way. The telescope was named the Hubble Space Telescope. Because we like to name things after great scientists. Marie Curie got a unit, like Newton, Joule and Watt and Ohm. Einstein and Rutherford got elements, Einsteinium and Rutherfordium. Hubble got a telescope.

In 1995 the Hubble Space Telescope was used to study a patch of sky, about the size of your thumb nail held at arm's length, thought to be empty of stars. The telescope was focused on this piece of empty space for about two weeks. When the picture was eventually developed the

information it contained was as mind-blowing as Hubble's original discovery of a second galaxy. The bit of space was not empty at all. Within that tiny patch of sky over 3000 points of light were captured. And each point of light was another galaxy. Impossibly distant. Thousands of galaxies, each containing hundreds of billions of stars. In one tiny patch of sky. It is well worth looking up. The Hubble Deep Field image prompted further research. It turned out where ever we look in space, every tiny bit of sky is teeming with galaxies. Hundreds of billions of galaxies, each containing hundreds of billions of stars.

So, what was I trying to achieve with this assembly? Much like last week, I hoped to encourage you to always work hard on your learning. I hoped to impress upon you the importance of knowing things, as opposed to being able to look them up, because you can only really apply, manipulate and link data and information if you know it in the first place. I hoped to wow you with the story of Hubble, and the awe inspiring nature of our universe, and perhaps get you to reflect on our

place in it. And, of course, I hoped one of you might be able to tell me what Taylor Swift's song was actually about.

Thank you for listening.