Best Practice

A guide to communicating astronomy with storytelling in planetariums

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Because storytelling is a powerful communication tool, many advocate for its use for communicating science. However, astronomical storytelling is not so straightforward for those starting out in the planetarium field who might not know how to create a story from scratch. In this article, I will review the evidence for the effectiveness of storytelling, how stories have been defined in media, and the various types of storytelling frameworks that have been advocated for use in communicating science. I show how the And-But-Therefore (ABT) framework can describe most types of stories, including fulldome videos, and can be used to create compelling content for planetarium presentations. I give example story outlines and present a general guide on converting any science account into the ABT story form.

Introduction

Even with increasingly sophisticated visuals, planetariums could not have remained popular since their inception without compelling programming to draw in an audience. It is commonly agreed by planetarians that to be successful, shows must have good stories to go along with the visuals. To support story creation within the industry, workshops and articles have appeared to describe best practices for script writing and show creation (e.g., *Spitz, 1960; Chamberlain, 1972a, 1972b, 1972c; Siemasko, 1986; Biddy, 1986; Meader, 1993; Lavoie, 2000*). From 1978 to 1994, a dedicated column appeared in *Planetarian*, the International Planetarium Society's (IPS) quarterly journal, which showcased notable scripts and featured contributed columns with advice on storytelling and writing. Best practices from dozens of planetarium professionals over the years were compiled into collections of tips on storytelling and scriptwriting, with the last update appearing in 2005 (*Tidey, 2005*). As fulldome video has become more common in the last two decades, articles describing cinematic best practices for presentations in digital domes have also appeared (e.g., *Yu et al., 2016, 2017; Wyatt, 2019; Daut, 2020*).

Yet despite this wealth of resources, there is little for the novice planetarian at the beginning of their career to learn how to construct a story or even to discover what defines a story. The work cited above provides a vast compendium of advice for crafting scripts, how to marry visuals with narration, and the unique cinematic aspects of fulldome video. However, although these authors encourage storytelling, the details of what makes a story a story at its basic level are sparse. *Chamberlain (1972a)* simply explains that stories must have three parts: an introduction to capture the audience's attention, the body containing the main programme, and an ending so compelling that it makes the audience want to return. *Lavoie (2000)* advocates six-part scripts based on his experience in film production. Although missing in the planetarium literature, the definition of story and descriptions of its structure abound in books and articles about storytelling in film, TV, and literary fiction (e.g., *McKee, 1997; Brody, 2018*). Although digital planetariums are a new medium that communicate in ways that are different from its sister media like film or virtual reality (e.g., *Yu, 2005; Daut, 2020*), the same story fundamentals apply to them as to forms of media that have existed for much longer. This paper attempts to synthesise the consensus about story structure by exploring the extensive literature on story science to create story creation guidelines for those with little practical experience in storytelling. As we will see, this toolkit for science storytelling is beneficial for those starting out in planetariums and anyone interested in using storytelling for their science communication practice.

Storytelling is a universal property of all human cultures (e.g., *Brown, 1991*). It organises our personal experiences and is pervasive in our lives (*Gottschall, 2012*). Narrative allows people to communicate their experiences with one another and subsequently alter each other's beliefs and behaviours (e.g., *Scalise Sugiyama, 2005; Avraamidou & Osborne, 2009*). Storytelling may have evolved as a cognitive tool to simulate the types of problems humans encounter (e.g., *Scalise Sugiyama, 2005; Gottschall, 2012*). Modern-day hunter-gatherers, the closest analogues we have to how our early ancestors lived, can spend up to 80% of their time around campfires telling stories (*Wiessner, 2014*). Good stories engage and help develop the imagination and capture attention by making the audience anxious to hear what comes next and how the story ends (Hadzigeorgiou, 2016). Stories are convincing because they portray information in the context of human experience, showing that transformational change is possible and motivating us to act (*Erickson & Ward, 2015*).

Research suggests that the effectiveness of narratives is due to their built-in cause-and-effect structure (*Dahlstrom, 2010; Graesser et al., 2002*), which makes them easier to read and more memorable than other forms of information delivery (*Zabrucky & Moore, 1999*). Facts inserted at causal locations in a story, where earlier and later events in the plot are linked as cause and effect, are more easily recalled than those inserted elsewhere (*Dahlstrom, 2010*). Powerful stories can create similar emotions and reactions in different audiences (*Immordino-Yang, 2011*) by engaging the same parts of the brain of the storyteller and the listener (*Hasson et al., 2008; Stephens et al., 2010*).

As tension increases during a story's dramatic arc, neurochemicals tracing empathy and attention also increase in parallel in the audience (*Barraza et al., 2015*). Stories maintain their grip because this tension makes us want to learn what happens next (*Zak, 2014*).

Audiences also find messages in narrative form more credible. Listeners identify and empathise with characters in the narrative, which weakens prior beliefs held by the audience that are counter to the story's message (*Dal Cin et al., 2004; Green, 2006; Kelly et al., 2014*). Stories that feature a heroic protagonist can be more effective for teaching science concepts than information in a traditional, expository form (*Hadzigeorgiou et al., 2012*). Both facts and misinformation from fictional narratives are so easily incorporated into people's knowledge about the world that readers of stories may believe they knew this information (and misinformation) before being exposed to the story (*Marsh et al., 2003*). Narratives that transport the audience into the world created in the story can change beliefs and motivate action (*Green & Brock, 2000*). The supporting research suggests that "people are 'wired' to be especially sensitive to information in narrative format" (*Green & Brock, 2003*). As a result, both scientists (e.g., *Krzywinski & Cairo, 2013; Dahlstrom, 2014; Enfield, 2018; Joubert et al., 2019*) and science communication advocates (e.g., *DeWitt, 2013; Barker, 2019; Foot, 2019; ElShafie, 2018*) have called for scientists to use storytelling to communicate more effectively with the public.

Early astronomical knowledge was likely transmitted via storytelling (e.g., *Hamacher, 2022*). Stories are used in many traditions to teach how to navigate by the stars (e.g., *Aveni, 1993*). They also help people learn to link seasonal changes to changes in the sky (e.g., *Krupp, 1983; Barber & Barber, 2004*). Before written records and calendars, people used the first heliacal rising or setting of a star or an asterism, or the orientation of an asterism relative to the horizon to mark the appearance of environmental phenomena crucial for survival, such as the start or end of rainy seasons, the migration of animals, and the appearance of flowers and other changes in plants. Storytelling was used to transmit knowledge about which asterisms to use, how to identify them, and how their positions, rising and setting times change during the year. Because oral traditions long predate writing, we can infer that humans in cultures worldwide learned basic astronomy through story for millennia.

Yet, despite the interest of the public, it is difficult for most people today to connect with modern astronomy. The concepts are remote and can seem irrelevant to people's everyday lives compared to other fields of science that involve medical discoveries or environmental pollution (*Storksdieck et al., 2002*; also see Figure 7.3 in *NSB, 2018*). Many topics involve abstract and non-intuitive phenomena with which the public has no personal experience. Finding ways to make astronomical content more appealing, such as through storytelling, would help improve teaching, public outreach, and public perception.

Some of the recommendations for effective stories can be easily adopted. For instance, the intrinsic awe of many astronomical phenomena visualised in a planetarium makes constructing stories about the cosmos easier, satisfying recommendations that a story must emotionally connect with an audience (*Martinez-Conde & Macknik, 2017*). However, other story elements are harder to adopt, such as requiring that a story have human protagonists who move the action forward (e.g., *Norris et al., 2005; Avraamidou & Osborne, 2009; Dahlstrom & Ho, 2012; Klassen & Froese Klassen, 2014; ElShafie, 2018*). In a story about their own personal research work, a scientist can easily recall their setbacks and successes and use them in the narrative. However, this approach becomes more difficult when trying to portray work that is not our own. As astronomy communicators and educators, we are familiar with the struggles of a small number of well-known historical figures, such as Galileo. However, we are not aware of the discovery process for most historical and even recent astronomical research, and it can take considerable time and effort to construct a science story using a historical approach (*Klassen & Froese Klassen, 2014*).

In the following sections, I will review the recommendations that have been made for science storytelling. Because the And-But-Therefore (ABT) framework seems to be the most adaptable for many different types of narratives (*Olson, 2015*), I will describe how it can describe planetarium programs, including fulldome films, and how to use it to create astronomy stories with and without human characters. I introduce a classification scheme for different types of astronomical narratives and include example outlines of such stories. I conclude with storytelling guidelines that can be used to generate a narrative outline for any science topic in and outside the planetarium dome.

The Nature of Narrative Stories

A pioneer in analysing story structure is *Gustav Freytag*, who, in 1863, used a five-act structure to describe narrative arcs in tragic theatre *(1900)*. The "Introduction" sets up the story and launches the plot. In the "Rising Movement" (commonly referred to as "Rising Action"), the story becomes more complicated as it moves toward the "Climax". The Climax, located near the middle of the narrative, is an inflexion point where the protagonist's fortune changes. In tragedies, the protagonist begins their long descent to mirror their ascendance in the first half of the narrative, whereas, in comedies, the fortunes of the protagonist begin to improve after having suffered earlier defeats. This reversal of fortune occurs during the fourth "Falling Action" act. The final act is the resolution, where we see characters die in a tragedy or go on to live happily ever after in a comedy. Although often called the "denouement" because the different story threads are resolved, Freytag called this the "Catastrophe" as he was primarily interested in tragedies.

There have been attempts to show how scientific narratives correspond to Freytag's structure (e.g., *Lavoie, 2000; ElShafie, 2018; Härmä et al., 2021; Meuschke et al., 2022*). Although it can be useful in organising our thinking about the presentation of scientific research, a five-act structure is unwieldy. Because it originated from scrutiny of tragedies, Freytag's framework is not widely used in modern analyses of popular media. Freytag's Climax does not resemble the commonly accepted definition of climax as a culminating event occurring near the end of a story. Thus, when Freytag's story structure is adopted, its definitions have often been misinterpreted or altered, with terminology—like "denouement"—added that Freytag did not use (*Bunting, 2021*).

More relevant to us is the three-act structure, which is most commonly used today to describe stories in popular media. The idea of stories having three parts dates back to

Aristotle, who simply contended that dramas must have a beginning, a middle, and an end (*1995*). Although the details of modern narrative structure depend on the author describing them (e.g., *McKee, 1997; Snyder, 2005; Vogler, 2007; Coyne, 2015; Bennett, 2020*), most three-act descriptions involve a setup introducing the characters and their world, using an inciting incident to set off the plot, a second act where tensions build over time as the protagonist has both successes and setbacks and a final third act where the tension reaches a climax. The story ends with a resolution after the protagonist has a final triumph or failure.

I will next explore two different types of story structure that have been advocated, one grounded in a three-part story structure and the other focused on character-driven plots.

And-But-Therefore Storytelling

The And-But-Therefore framework was first described by *Randy Olson*, who left his tenured professorship in marine biology to attend film school to learn storytelling, become a filmmaker, and be a better science communicator (*2009*). Based on his experience studying film entertainment, Olson argued that science communication must incorporate elements of narrative storytelling to compete with more dominant forms of media that are better at grabbing public attention (*Olson, 2019; 2020*). He notes that those from scientific backgrounds often give talks that present one fact after another. He calls this the And-And-And approach (*2009; 2015*) because each factual statement is effectively separated by the word "and." AAA can work in small doses and is usually compelling for those in the "in-group" already interested in the topic. However, if it is the only type of delivery, it is unlikely to captivate the members of the far larger "out-group" who have little initial interest (*Olson, 2015*). Without context to make someone care about the topic, an AAA approach cannot force them to invest in the story.

However, if a narrative is instead cast into a traditional story form, the audience is more likely to be interested in what is being communicated and desire to learn more (*Olson, 2009*). As an alternative to the AAA framework, Olson promotes And-But-Therefore (ABT), which he synthesised from the three-part structure commonly used to describe how popular stories work in film, TV, and other mass entertainment (*Olson*, *2015*; *2019*). ABT is similar to the principles used by the creators of *South Park* (*MVTU, 2011*) and adopted by Pixar for their films (*McDonald, 2005; Bennett, 2020*).

The ABT elements correspond to the three main components of any story (*Olson*, *2019*): agreement, contradiction, and consequence. ABT can describe plots of popular films, where characters and environments are set up in the "And" introduction, a conflict is introduced in the "But" section, and characters have to resolve this conflict in the "Therefore" segment. Because it was derived from investigations of popular film, ABT can be used to describe the structures of many, if not most, fulldome planetarium films. Films that follow a character on a quest to solve a problem almost always follow a three-act or ABT-like structure. The plot of *321 Liftoff!* (*2022; dir. M. Živocký*), a kids' film filled with charismatic computer-generated characters can be described as:

> Elon the Hamster has a dream of flying, **AND** the contraptions that he builds always fail. **BUT**, one day, the alien Eight-of-Twelve lands in his junkyard after falling from her spaceship in orbit around Earth. **THEREFORE**, Elon becomes committed to figuring out how to get Eight back to her companions.

There is obviously more to the film than described in this brief outline. The characters' attempts to travel by balloon, aircraft, and rocket are all necessary to deliver the science points and make the film fun to watch. However, they are in service to a plot, which is fundamentally ABT when stripped down to its core.

Science documentary films are filled with fact-filled segments, each of which is typically in AAA form. But again, there is usually an underlying structure that is in ABT to which the AAA portions are attached. *Incoming!* (*2016; dir. R. Wyatt*) is populated with descriptions and visualisations of recent scientific discoveries about asteroids and comets. But if it had to be summarised in a few sentences, ABT provides a model for how:

> Earth and life on it have long been shaped by impactors arriving from space. **BUT**, there is a limit to what we can learn with our ground-based tools. **THEREFORE**, we have sent spacecraft out to explore these Solar System bodies to discover their deep connections with our planet.

In a similar vein, *Dawn of the Space Age* (*2005; dir. R. Sip*) consists of multiple short chapters illustrating the history of spaceflight. Each segment delivers multiple facts in AAA style. Yet, they are in service to a story that is at heart ABT:

> Humans have long dreamed of going into space. **BUT** they did not have this ability for much of their history. **THEREFORE**, humanity had to wait until technology caught up with this desire in the 20th century when nations first competed and later collaborated to reach different space milestones.

ABT is universal enough to describe the structure of other narrative media, such as fairy tales, poems, songs, and corporate logos (*Olson, 2019; 2020*). When applied to nonfiction, ABT can be considered a setup, problem, and solution. In a science story's "And" section, the storyteller gives introductory facts and basic information on which everyone can agree. The second part introduces tension with the "But" statements. These contradict the facts presented in the "And" section, with the conflict stimulating the audience's interest. In the final "Therefore" portion, new answers are given, the conflict is resolved, and the story is concluded. The "But" and "Therefore" sections mirror the cause-and-effect framework that explain why stories have such power to grab and hold audiences (*Dahlstrom, 2010*).

Instead of focusing on the overall narrative arcs in films, let us look next at examples of how we can reorganise astronomy topics into variations of ABT.

Astronomy ABT Basic Examples

Below are examples of outlines that explain three different astronomical concepts through ABT:

> **Heliocentric Solar System**
> Educated people thought Earth was at the centre of the Universe **AND** that the Heavens were perfect, **AND** celestial bodies moved along circular paths around Earth. **BUT**, with better observations,

a model that accurately showed the motions of planets became more and more complicated. **THEREFORE,** Copernicus proposed a simplified Sun-centred Universe.

What Are Stars Made Up Of?
Stars are distant suns **AND** spectra can be taken of their atmospheres to sample their chemical makeup. **BUT** there was no consensus on what led a star to have the spectral lines that it showed. **THEREFORE,** an approach that combined gas physics with astronomy was needed. Cecilia Payne-Gaposhkin applied the new understanding of how hot gases emit and absorb light to the atmospheres of stars to show that stars consist mostly of hydrogen and helium.

Discovery of Black Holes
Most stars are in binary systems **AND** they can be observed via their distinct spectra even when the two stars are so close that we cannot see them separately in the sky. **BUT**, there are some binary pairs where one of the stars appears to be invisible or missing! **THEREFORE,** black holes were proposed as a solution to this mystery.

In these examples, the storyteller needs to know how successive observations and interpretations causally lead to a better understanding of a topic. The questions raised in the "But" section perplex scientists, creating tension in the story. This tension is not resolved until the "Therefore" section when new data or explanations are brought in to clear up the conflict. The added tension helps keep the audience's attention: after the problem is introduced, they want to see how it is resolved.

Misconceptions-Based ABT Stories

The "Misconception-Based" ABT story has as its theoretical underpinning constructivism: the educational theory that purports that we all hold mental models about how the world works around us, informed by prior experience and teachings, but frequently at odds with scientific thinking (e.g., *Brewer, 2008*). Newly acquired scientific information does not immediately overturn prior misconceptions. However, it can lead to synthetic models that combine the old with the new (*Vosniadou & Brewer, 1994*), with the transformation of synthetic to scientific models taking place slowly over time. To speed up this process, contradictory information can be introduced that adds doubt in the mind of the learner and helps to promote conceptual change (*Bakas & Mikropoulos, 2003*).

In the following ABT story outline, we start with commonly held incorrect notions by the public about the cause of the seasons (*Atwood & Atwood, 1996; Zeilik et al., 1999*). The "But" section introduces contradictory information to create doubts about prior mental models. This contradiction is resolved in the final "Therefore" section, where the scientifically correct description is presented as an alternative. To develop this type of ABT story, the storyteller must be familiar with common misconceptions and the information needed to address them.

Seasons
Over the course of a year, we experience the seasonal cycle with changes in temperature and the amount of daylight. **AND** if you ask someone, they will attribute the seasons to Earth moving in an elliptical orbit so that it is closer to the Sun in the summer. **AND** some people think seasons have to do with the tilt of the Earth, putting a part of its surface closer to the Sun.

BUT the Earth is actually closest to the Sun in early January, when it is northern winter. The seasons are also simultaneously different for people in the two hemispheres. Finally, the distance between the Sun and Earth is so vast that Earth's tilt negligibly alters the distance to the Sun at different latitudes.

THEREFORE, the reason for the seasons is not different distances to the Sun, but the Earth's tilt changing how high the Sun is in the sky during the day, and the length of the day.

Character-Driven ABT Stories

Most stories told in human history have involved human characters or non-human characters with recognisably human traits. The audience can connect with them, understand their goals and motivations, and empathise with their very human struggles. The drama comes in seeing the problems they face during their journey of discovery, with missteps and triumphs along the way, and witnessing how they ultimately succeed. For planetarium stories centred on scientists (who could be depicted by actors, animated via computer graphics, or whose story is just narrated by a live presenter), dramatic tension can come from any stage in the scientific process. Many planetarium shows employ non-scientist characters who are stand-ins for the audience. They may have questions they cannot immediately answer and must go on a journey or accomplish tasks to understand the science the show is trying to convey. By depicting the struggles of scientists or fictional characters in the narrative, the audience can be transported into the character's shoes and empathise with them in their trials.

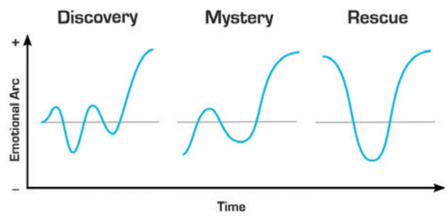

Figure 1: *The three types of narrative arcs for science stories with human protagonists from Green, Grorud-Colvert, & Mannix (2018).*

Green, Grorud-Colvert, & Mannix (2018) describe three scenarios for character-driven science stories: the Discovery, Rescue, and Mystery plots (Figure 1). Each journey's emotional highs and lows can be plotted across time as story shapes, with the final discovery representing an emotional high at the end. The Discovery story shows the protagonist overcoming adversity as they conduct experiments or make field observations, analyse their data, and move closer to the discovery. In the Mystery story, the main protagonist starts at a low point with a mystery or puzzle that must be solved. Like journalistic depictions of scientific discovery that take the form of a detective story, the scientist gathers new facts to eliminate alternative hypotheses to uncover the mystery (*Curtis, 1994*). Finally, in the Rescue plot, scientific results are viewed as solutions to challenges faced by individuals or society, where they begin at a high point and suffer loss, which is reversed only by a new scientific discovery.

I propose a new story category in addition to the normal Discovery. Much astronomical knowledge is based on the accumulation of work by multiple figures, creating a broad historical sweep of discoveries. This "Extended Discovery" involves multiple personalities working over a span of time. The drama comes from humanity's collective efforts to better understand nature. Within the larger narrative are multiple embedded ABT arcs, each of which can be a self-contained story. The following expands on the Copernican example from the start of this section.

Heliocentrism and Motions of the Planets
Classical thinkers once believed that the Earth was made of imperfect elements **AND** the heavens were perfect. Observations showed that the Sun, Moon, and planets appear to travel around the Earth.

BUT with more detailed observations, models that could accurately depict the observed motions became increasingly complicated. Also, new telescopic observations showed that not everything orbited the Earth, and the Heavens were not perfect.

THEREFORE, Nicolaus Copernicus proposed that not everything travelled around the Earth, but instead, moved around the Sun.

The Copernican model was successful in explaining some phenomena.

BUT it still relied on circular orbital motions, which meant epicycles were still required.

THEREFORE, nearly a century later, and based on careful observations of planetary motions, Johannes Kepler proposed elliptical orbits, with the planets moving faster when closer to the Sun and slower when further away.

In a science Mystery, the storyteller must understand the discovery process enough to show how the researchers worked past red herrings and other obstacles to get to their discovery. While this following example is part of a larger cosmology Discovery story, the narrative elements from first-person accounts (*Bernstein, 1984*) can be made to fit a Mystery ABT story:

Cosmic Microwave Background
Arno Penzias and Robert Wilson were trying to use a radio telescope to measure radiation from the Milky Way. **AND** in order to do that, they had to characterise any noise that could muddle their observations.

BUT there was leftover static detected even after accounting for all possible sources of noise.

THEREFORE, after eliminating other explanations, Penzias and Wilson recognised the "noise" they observed was really relic radiation from the Big Bang.

It is rare that a space science discovery is in the form of a "Rescue Story" since these revelations rarely save an individual or society. Here is one example that does have consequence:

Near Earth Objects
The main asteroid belt lies between Mars and Jupiter. **AND** since their formation, major and minor planets have continued to placidly orbit around the Sun.

BUT evidence has grown that larger planets can change the trajectories of smaller bodies. Geologists realised that impacts have altered the history of life on Earth. We now acknowledge that asteroids and comets can be hazards to human civilisation.

THEREFORE, astronomers and planetary scientists developed space- and ground-based surveys to find all objects that had the potential to collide with Earth. **THEREFORE,** plans were developed to test out new technologies to deflect objects.

Guidelines for Non-Character Driven ABT Story

Based on these examples, it becomes clear that we can generate non-character-driven astronomy stories by answering the following questions:

- **AND:** What are the basic background facts that an audience needs to know?
- **BUT:** What are the unresolved questions? What new information contradicts the basic facts?
- **THEREFORE:** What are the new observations, discoveries, or thinking that is needed to address the unresolved questions or contradictions?

Using these simple questions, we can construct ABT story outlines out of nearly any astronomical or planetary science topic, even when we are not entirely aware of the historical circumstances surrounding the discovery or the personalities involved. Below are some outlines for a range of topics.

Wet Mars
Mars is a dry desert world **AND** there is no liquid water on its surface today. **BUT** spacecraft images show surface features that look like channels and deltas carved by water. **THEREFORE,** we speculate that Mars must have been warmer and wetter in the past, and it has since lost most of its water.

End of low-mass stars
Stars generate energy in their cores via fusion **AND** this outgoing energy balances the mass of the star pressing inwards. **BUT** what happens at the end of a low-mass star's life when its fuel starts to run out? **THEREFORE**, we need to look at the physics of the stellar interior when the stellar core runs out of hydrogen fuel in order to understand how a star evolves at the end of its life.

Exoplanet discoveries
We suspect that our Solar System isn't unique in the Universe **AND** we expect planets to be found in orbits around other stars. **BUT** observing planets directly is very difficult because of how much brighter stars are than their planets. **THEREFORE,** we need new techniques for finding planets, such as measuring radial velocities or observing transits.

The radial velocity method requires careful measurements of stellar velocity changes from an orbiting planet. **BUT** this stellar motion was too small to measure with spectrometers at the time. **THEREFORE,** new spectrographic techniques were needed to make detections.

Once we have identified a question that a discovery answers, we have all the elements needed to generate an ABT story. We can, therefore, create ABT stories not only about venerable topics but also about the numerous discoveries that are announced in press releases or press conferences each year.

The last example for exoplanet discoveries also shows how the ABT method can be recursive: the follow-up about the limitations of the radial velocity method is also in ABT.

The embedded nesting of ABT in a story ensures that audience interest is maintained at multiple levels in the narrative (*Olson, 2020*).

We close by showing how a documentary-style fulldome film can also contain multiple layers of ABT. The overall story arc of *We Are Astronomers* (*2016; dir. M. Crow*) can be summarised as:

> Humans have long tried to make sense of an awe-inspiring Universe. **BUT** their understanding was limited. **THEREFORE,** they had to invent new tools and instruments to allow them to know the nature of the Universe, with the added benefit of bringing diverse groups to work together.

Instead of presenting the multiple astronomical topics it covers using only AAA, the film approaches some with ABT, such as the section on the *James Webb Space Telescope*:

> Astronomers built many telescopes to observe the cosmos. **BUT** ground-based observatories couldn't explore all parts of the electromagnetic spectrum. **THEREFORE,** astronomers launched telescopes into space.

The climactic story of the Large Hadron Collider is also set up as ABT:

> Telescopes have imaged further and further back in time. **BUT** there is a limit to how close to the Big Bang astronomers can probe. **THEREFORE,** we had to turn to particle physics to provide answers regular telescopes could not.

Other chapters of the film are done as pure AAA, such as a fact-filled review of spectroscopy. However, with a slight change of the script, the film's account of Galaxy Zoo could have turned this information-loaded AAA segment into ABT as well:

> Astronomers are acquiring more and more telescope data. **BUT** this data is often more than the professionals can analyse. **THEREFORE,** new crowd-sourced projects have been created, allowing enthusiastic amateurs (who outnumber the professional astronomers) to be involved.

Concluding Thoughts

After showing that stories are a useful way to communicate science, I have presented different examples of And-But-Therefore in the narrative arcs of fulldome films and in individual astronomy topics that can contribute to segments of a dome film or presentation. I have followed that with a description of how any science story can be recast into ABT. Nevertheless, this approach requires a different mindset and the exercise of different skills for those (including the author) who have spent most of their careers delivering information in the And-And-And style. With planetarium visualisation software, it is easy to create tours of the Universe (*Emmart, 2005*) filled with AAA content, with the presenter reciting a handful of facts at each stop before flying off to the next destination. This approach has visual appeal, as the audience can fly through space and see diverse phenomena. However, storytelling research suggests that the audience could get more out of the narrative if there were an ABT wrapper around all of the AAA components.

From my experience, creating presentations using the ABT approach is difficult at first, and practice is needed to make this process easier. Therefore, I encourage readers interested in a story-focused approach to practise constructing ABT stories themselves. Using this framework and other recommendations for creating compelling narratives (e.g., *Schimel, 2012; Corner, Shaw, & Clarke, 2018; Olson, 2020*), practitioners can improve their planetarium presentations and enhance their communications for any audience.

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Biography

At the Denver Museum of Nature & Science, **Ka Chun Yu** has written planetarium visualisation software, helped produce movies for the digital dome, created Earth systems planetarium shows, and researched how digital planetariums can be used to teach astronomy. He participates in extensive education and public outreach and advises on science content in permanent and temporary museum exhibits.