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Embedding Popular Culture to engage learners in STEM and other subjects

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Description | What was done?

Popular culture has been included in teaching resources for a significant period of time, though literature indicates that it is more common in the Arts and Humanities than in Science, Technology, Engineering and Mathematics (STEM) disciplines (Peacock et al., 2018). The appearance of STEM topics in television and movies has been credited with motivating students to further their study in STEM subjects (STEMeducationworks.com). Given this connection it makes sense to seek to drive student engagement by having some of those entertainment media appear within our STEM classes. Using Popular Culture to make teaching more engaging is a topic which has been widely discussed (Benson & Chik, 2014; Clapton, 2015; Clauss, 2009; Skluzacek et al. 2010; Dune et al. 2016). In fact, the use of literature, art and music have been to supplement teaching Chemistry is extensive (Dietrich et al., 2021) and this includes jazz (Crowther & Davis, 2013), opera (André 2013; Cobb 2013), as well as works by Agatha Christie (Southward et al. 1992), Shakespeare (Kloepper, 2015) and even James Bond novels (Last, 1992). This resonates personally with the author, harking back to student days and Physical Organic Chemistry lectures with Professor A.P. de Silva at Queen's University Belfast where an analogy of James Bond was utilized to describe molecular sensors. This clearly worked since the concept is still understood and the analogy vividly remembered almost twenty years later.

Television has also been influential in similar ways (Dietrich et al., 2021). The current Case Study is primarily inspired by watching the popular animated sitcom, *The Simpsons*. A body of work that began more than a decade ago, this is a topic which considers the contribution of Popular Culture in STEM Learning, but also in other disciplines. Some of these ideas have been presented to general audiences at outreach events and QUB Development Week activities since 2018, while some of the specific examples have been utilized in teaching content for undergraduate courses on Mathematics, Thermodynamics and Sustainable Energy since 2011. Some of these lectures can last for two hours and so it can be challenging for both faculty and students to remain engaged and enthusiastic, particularly when the subject matter has a deep theoretical foundation, as is the case for topics such as thermodynamics and mathematics. The need to maintain student concentration for the duration of lessons can be enhanced using relatable materials which are also relevant to the subject matter. This aspect remained just as important, if not more so, during the periods of remote online teaching and isolation of students. While still attempting other means to break up the content (e.g. suitable break periods broadcasting popular music to the online classroom) the use of Popular Culture to pique interest at various points throughout the lectures was of substantial benefit both to the students and indeed to myself when it often felt like lecturing into an abyss of initials icons on MS Teams.

Motivation and Aims

INSPIRED BY QUIZZES

As a child, many traditional quiz shows broadcast in the UK and Ireland such as University Challenge (similar to College Bowl in USA), Blackboard Jungle, Mastermind or Fifteen to One seemed to be at the highest intellectual level, often causing frustration and disenfranchisement when unable to answer some of the questions. It was not just about knowing the answer but also a frustration at the pace and intensity of these formats that meant there was no opportunity for learning. Such feeling was perhaps magnified by the sometimes clinical and often blunt delivery by the hosts. The evolution of entertainment quiz shows, some of which use comedians as hosts as well as celebrities as panel guests/contestants changed this. Perhaps one of the better-known examples of this is QI (Quite Interesting), formerly presented by Stephen Fry and more recently by Sandi Toksvig who, while still asking difficult questions, often offer some detailed explanations thereby allowing the viewer the opportunity to learn more effectively while also being entertained. There is perhaps a comparison with the evolution of University level teaching. When lectures were delivered as a monologue often with limited opportunity for student interaction thereby making attempts to engage challenging, learning was more agentic (Dune et al., 2016). This would result students attempting to recall what was said in a lecture during independent study time. If a lecture was not particularly engaging, then this would make these attempts to understand more challenging. In much the same way as Television Quizzes have evolved so too has the lecture, where often faculty will feel like entertainers as much as educators in order to drive student engagement and, hopefully, aid student recollection for that independent study time.

Regarding the appearance in STEM in Popular Culture, Pointless is a TV show where the lowest scoring answer wins with the goal to get a “Pointless” answer, i.e. one which is correct but that none of the survey respondents had managed to answer. One favorite topic is the Periodic Table and can lead to some healthy competition to get the best answers. As such, such platforms may be able to inspire and motivate learning in current students at all levels, and not just exclusively to Chemistry. This type of entertainment can also aid with attracting a wider audience while such formats can easily be integrated into teaching methods which can be engaging and stimulating (Dietrich et al., 2021; Clapson, 2020; Skluzacek, 2010). This could take on the format of pop Quizzes during lectures/classes thereby making them more enjoyable but also instilling a motivation in students to score the best answer. The psychology of using Popular Culture to educate is certainly not a new phenomenon, particularly in early years education; consider The Wombles as a medium to teach the importance of reduce, reuse and recycle, for example. The use of specific examples of Popular Culture to aid scientific learning at higher levels has also been reported previously (Clauss, 2014), including Jurassic Park (Crichton, 1990; Hollis, 1996). As previously reported (Hollis, 1996), this provided an opportunity to highlight the multidisciplinary nature of science, aspects of organic chemistry to High School students. One aspect which could be added, particularly if teaching at University, is to challenge the students to assess the feasibility of the science; i.e. is it actually possible to extract and clone from geologically ancient DNA preserved in amber? The answer is likely not and there is research to confirm this since DNA will not survive for millions of years as depicted in the book and movie (Austin et al.; 1997). But this does provide the opportunity to task students to undertake an evidence based assignment researching literature and present their own conclusions.

There is also the opportunity to discuss research ethics; in Jurassic Park Dr Ian Malcolm (played by Jeff Goldblum) states “your scientists were so preoccupied with whether or not they could, they didn't stop to think if they should”. Perhaps even the scene of Pete Venkman (played by Bill Murray) in Ghostbusters (1984) conducting a dubious electroshock experiment with two volunteers could be utilized to highlight issues around ethics in research as well.

Methodology

THE SIMPSONS IN CHEMICAL/SCIENCE EDUCATION

It was through watching one of these prime-time quiz/entertainment shows were the inspiration for this commentary originated. The question “Where was former UK prime minister Tony Blair born?” was asked. The answer, I knew, was Edinburgh. But then I realized where I had gained such knowledge; an episode of The Simpsons (The Regina Monologues, 2004) where the family visit the UK and this piece of trivia is imparted by Tony Blair himself upon greeting at the airport. Given that I had managed to recall this information I wondered what other ways learning could be enhanced through Popular Culture and specifically The Simpsons.

While The Simpsons have occasionally covered a range of historical and literature references such as Joan of Arc and Hamlet (Tales from the Public Domain, 2002) and Ulysses (In the Name of the Grandfather, 2009) which might serve as initial inspiration for some to pursue further study in the areas of history or literature, it has also regularly covered a number of scientific topics. For example, while visiting The Giant's Causeway (In the Name of the Grandfather, 2009) we are informed that the causeway was formed as the result of a volcanic eruption. The concept of carbon dating was also introduced (Lisa the Skeptic, 1997) while some of the major events in the history of nuclear physics was summarized in a science fair diorama (Fat Man and Little Boy, 2004). Furthermore, there is reference to nuclear physics/atomic structure with the mention of “The Boring World of Niels Bohr” (I am Furious (Yellow), 2002). Genetically modified foods/plant hybrids have also been highlighted on several occasions (E-I-E-I-(Annoyed Grunt), 1999; The Man Who Grew Too Much, 2014). Additionally, when teaching Mathematics there are a number of lighthearted moments that can be used to reinforce learning; for instance, “ $\sqrt{-1} = 23 \sum \pi \dots$ and it was delicious” (Mathlete's Feat, 2015) alludes to the use of i in complex numbers (i.e., I ate some pie... and it was delicious) while there is also the use of ASCII to spell “Frink Rules” (Treehouse of Horror VI, 1995).

Furthermore, Faraday's Constant and The Speed of Light also feature in one episode (Dark Knight Court, 2013). The instant recall of such values by Mr Burns and Comic Book guy serve as a reminder of how well students should recall their own relevant constants. Further detailed examination is discussed elsewhere (Halpern, 2007). These examples are by no means an exhaustive list and each provides an opportunity to aid knowledge retention by providing some light hearted relief from what can otherwise be quite tedious teaching material. In fact, most of these examples are a regular feature of the author's own teaching content for Mathematics and Thermodynamics.

Some further useful examples that can be used for teaching Chemistry also include an episode in which Lisa has developed a perpetual motion machine which keeps getting faster and

faster (The PTA Disbands, 1995). This provides the opportunity for Homer to declare that they “obey the Laws of Thermodynamics”. As such this is a way in which teaching the Laws of Thermodynamics can be reinforced. Such a machine is contrary to these laws which state that energy cannot be created or destroyed, but rather converted from one type of energy to another. Consequently, a perpetual motion machine that does not suffer losses (and in this case gains momentum) is not possible if one considers the Laws of Thermodynamics.

In terms of calculations it has also been useful to refer to Mr Burns’ metric trap where a 1000g weight is dropped on Homer. Much to Mr Burns’ disappointment, the weight has little effect on Homer, leading Mr Burns to state that it “sounded larger when I ordered it...” (Who Shot Mr Burns (Part 1), 1995). This is an opportunity to instill the importance of units to students in that the size of any number can only truly be determined when the units are also considered. This is very important aspect when teaching, for example, Equations of State in Thermodynamics; there are various equations and in some cases several ways in which these equations can be written. It is critical for the learning outcomes in this instance that the students know to take time and ensure that they are using any provided data with the correct units in a chosen equation, as well as identifying the times when data may have to be converted to the correct units to be used in an equation. Again, these various examples for Thermodynamics and importance of units are regularly used at various points in the author’s teaching content and the importance of units reiterated with the story of the 1999 Mars Climate Orbiter. This NASA mission resulted in the complete destruction of the Orbiter and failure of the mission as the contractor did not use the proscribed SI unit format and only communicated numbers to the software expecting the values in the correct units; thereby resulting in significant miscalculations which caused the loss of \$125M worth of equipment (Grossman, 2010).

Several aspects related to the environment have also been raised in some episodes including an oil spill (Bart After Dark, 1996), pollution (The Simpsons Movie, 2007), alternative fuels/sustainable energy (The Squirt and The Whale, 2010). Perhaps the most interesting concept here is if we consider the current global interest in combating plastic waste, particularly in the oceans. While many rightfully point to Sir David Attenborough and Blue Planet II as a major catalyst for this long overdue interest in reducing plastic waste, The Simpsons highlighted the same issue nearly 20 years previously (The Old Man and The Lisa, 1997). In terms of sustainability, there are other Popular Culture references which have been drawn on for lectures; for example, in Back to The Future II when Doc Brown refuels with waste from a bin and the fact that Monster’s Inc drew inspiration from the 1970s oil crisis and the pursuit of alternate energy sources that arose from that. These examples have all been used by the author for content related to the environment and sustainable energy.

CONCLUSION

The above discussion is intended to highlight the potential of Popular Culture as an important supplementary role to education. Examples used personally for delivery teaching have been discussed as have some of the anonymous feedback via TEQs which mentioned the use of Popular Culture. These are important points given the theoretical concepts that is often delivered and one of the major challenges is maintaining student engagement throughout a lecture. It seems that the inclusion of references to Popular Culture is a useful addition, by offering the students some relatable content which promotes concentration and perhaps also

enhances learning outcomes and knowledge retention. Besides, having some entertaining excerpts as part of a lecture also has the potential to improve and maintain attendance, particularly during full schedules and approaching deadlines for submissions; i.e. if the faculty member is enthusiastic and entertaining about the subject matter the students will be more likely to attend the scheduled classes. In the many trends, issues and challenges that came with the Covid-19 pandemic and indeed the constant evolution in the classroom/learning environment one key fact will remain; the need to connect with the audience and in ways that work for them. As such, the use of Popular Culture may well continue to be a useful educational resource that can help bridge this connection.

Literature Review

N/A

Successes | Challenges | Lessons Learned

One notable success after using GIFs and other media to reinforce the importance of units in calculations is when grading student work and there has been improved inclusion of units. It is further notable that students track the units through each step of calculation thereby ensuring that not only are the units included in the final answer, but that these units are also correct. A further success of this has been new colleagues who had attended Development Week activities (then as students) on this topic being inspired to take similar approaches, even in other disciplines.

It is worth noting that students themselves refer to the use of the Popular Culture in teaching materials. This has been evidenced over several years and a broad range of taught modules through the comments sections of Teaching Evaluation Questionnaires (TEQs). This is highly encouraging given that there was no leading questions or specific survey related to Popular Culture and students mentioned these within the standard framework of the TEQs. Some of the TEQ comments include:

“good use of media”

“incorporating videos made the lectures more interesting allowing you to keep focus”

“references to pop culture made the lectures more relatable and enjoyable”

“references to pop culture make the content more enjoyable to learn”

“lecturing style that was easy to listen to”

“made thermodynamics fun!”

“use of images/videos/gifs help brighten a heavy lecture and make content relatable”

The fact that such content has had this kind of impact reinforces the need to continue to engage with students to reflect upon and update the content as appropriate. Some of this content has been utilized for several academic years, so staying current in recent relatable media and Popular Culture will be necessary to continue to have impactful engagement and as such this is still very much an ongoing project. One way to do this is to engage with a range of stakeholders and social media can offer an opportunity to do this. One example is the

Science Teachers Book Club (@sciencebookgrp) which suggests and discusses popular science books on a regular basis and so provides the opportunity to discuss the latest topics with peers and a wider audience.

One further impact has been students approaching after a Lecture commenting on Popular Culture references and discussing a new book or a movie which covers similar areas and drives some further discussion on the topic. These types of interactions have been particularly rewarding since it demonstrates that students are engaged and appreciative of the content but also it allows updating of content to include more recent Popular Culture references. One specific example comes to mind since it was mentioned on several occasions, both after Lectures and during some Outreach Events; the movie *Dark Waters* is inspired by a true story about an environmental lawsuit related to chemical contamination. The inclusion of such a story in teaching content in relation to chemical Health and Safety is possible as is reference to the book which originally told the story (Lyons, 2007). This also prompted memories of the movie *Erin Brockovich* which focuses on a similar lawsuit related to groundwater chemical contamination which again could be used in relation to Health and Safety teaching but also as background context for legislation where chemicals have become more regulated and, in some instances, banned entirely.

Scalability and Transferability

As has been discussed in earlier sections, the concept of embedding Popular Culture to improve student engagement has been utilized for many disciplines (Peacock et al., 2018). Continued use of Popular Culture is possible and worthwhile in many disciplines and indeed those with those interests will be best placed to know the relevant materials. Immediately what comes to mind are movies like *Finding Nemo*, *Twister*, *San Francisco*, *The Perfect Storm*, *The Impossible*, *Gorilla's in the Mist* or *Dante's Peak* for Geography/Natural World Topics. Similarly, there is *The Big Bang Theory* or *Young Sheldon* for Physics. The great thing about all of these is that even if they are not accurate to the discipline this provides a learning opportunity; whether it's a discussion around misconceptions or even though an assignment were students are asked to critique the cultural references for scientific accuracy or some other purpose. It is anticipated that future work collaborating with colleagues in other disciplines to explore the use of Popular Culture more fully for learning would be a worthwhile exercise and the author encourages correspondence from any interested parties.

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Further Information

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