



EGUsphere, author comment AC2  
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## Reply on RC2

Thomas Clements et al.

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Author comment on "The perception of palaeontology in commercial off-the-shelf video games and an assessment of their potential as educational tools" by Thomas Clements et al., EGU Sphere, <https://doi.org/10.5194/egusphere-2022-84-AC2>, 2022

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**We thank Elsa for their thorough and useful comments - especially for the positivity found throughout the review. We very much appreciate it. Below we document our responses to their comments and the implementations made based on their comments:**

Line 28: As I comment later, the addition of some metrics (e.g. how many games surveyed) should be included in the abstract.

*We do not believe that the number of games available on Steam is relevant in the abstract. However, as mentioned below, we have increased information in the main text on the metrics.*

Line 43: Do you want to use the first person? 'We the authors' might be better kept separate from 'we the science communicators', by speaking about sci commers in the third person. Not a criticism, this is just a style comment and keeps it clearer. I suggest 'Those working as palaeontological science communicators should appreciate the size of....'

*This is a fair point. We agree that the way the manuscript is currently worded can cause confusion for the reader and should be changed. 'We' (the authors) have amended the manuscript to make it clearer when we are referring to science communicators*

Line 66: I couldn't find reference to this in this paper, could you double check that it supports this statement?

*We agree, Kerawalla & Crook, 2005, is not relevant a citation here and has been removed.*

Line 98: I agree with you, but I wonder if there is evidence to support this? If there is a reference supporting it then I suggest inserting it. If not, it might be better to make it clear that this is what you are suggesting could be the case, e.g. 'could have a huge impact on' and 'could mislead audiences'.

*Absolutely. We have changed the sentence as per your suggestion.*

Line 107: Might be worth adding something like '(see below for overview)' so that readers know you are intending to qualify this statement later in the paper.

*Thanks, we have added the text you suggested.*

Line 120: I would like to see a summary in this section of how many games in total you surveyed for this paper, with a pointer to the supplementary for a breakdown of all of them.

*See below:*

Line 122: Can you add any quantity to this section, just to summarise and reinforce your argument? If you could give a rough idea of the total number of games with palaeontological content, and the approximate number of people who have bought/played them, it will strengthen your statement that a huge number of people are introduced to palaeontological concepts this way, and reinforce the message of this manuscript.

*We have expanded this section to incorporate your comments. The text now reads:* There is a huge diversity of video games that contain palaeontological content. As of 2021, there are over 270 palaeo-themed COTS games available on Steam, the largest digital video game distribution service (PC games only) (Figure 2). It is important to note that this number does not include games that have been released for games consoles (such as the SNES, PlayStation, Xbox etc.) and so the number of palaeo-themed COTS games is much greater. Many of the games available on Steam are made by small development teams and will not sell in large quantities, however, mainstream titles can often sell large numbers of games. For example, by 2020 *Jurassic World Evolution* (2018, Frontier Developments) has sold over 3 million copies (Kerr, 2020). In this review, we focus on COTS video games that incorporate fossils and/or ancient animals as one of the playable or interactive aspects of the game, however, due to the vast quantity of these games there are titles that may not be directly discussed herein.

Line 135: Is [sic] it worth adding a sentence to clarify the difference between archaeology and palaeontology, and that these are often confused, and that archaeological games will not be discussed in this manuscript? Just a thought for those who may be less aware of the difference, they are commonly thought to be interchangeable.

*Good point. We have added the following sentence to the text:* In this review, we focus on COTS video games that incorporate fossils and/or ancient animals as one of the playable or interactive aspects of the game. This does not include games based on human remains or artifacts (archaeology).

Line 270: Is there any way to reference this statement/section - for example has there been any kind of cultural study about such touchstones and tropes?

*Good suggestion. We have included García-Sánchez et al. 2021 here.*

Line 281: Can this [monsterification] be referenced? Again, can this be referenced? Perhaps a paper in which shrink-wrapping versus fleshiness is tested, or of course there is the book *All Yesterdays*, and discussions such as <https://blogs.scientificamerican.com/tetrapod-zoology/dinosaurs-and-the-anti-shrink-wrapping-revolution/> where the idea of shrink-wrapping is explored.

*Monsterfiction is clearly described later in the text and we have alluded to . However, we agree that Conway et al. 2012 is a useful reference to use here and it has been included in the text.*

Line 326: The video game industry is part of the entertainment industry. Maybe rephrase, as currently it sounds as though you are suggesting it is separate.

*The video game industry is a sub-division within the entertainment industry separate from, for example, the film industry or music industry. Therefore, this sentence does convey the difference we mean.*

Line 388: Very specific, but not a well known classification for readers who are not into taxonomy/birds, suggest changing to 'the owl Blathers, the museum curator'

*This is a fair comment. We enjoy Blathers the strigiform museum curator, but we do recognise that this is quite an inaccessible term. To compromise we have added the word owl to the text to clarify the word strigiform.*

Line 446: I think there might be a decent amount of literature of teaching evolution through gaming, but I'm not certain - maybe worth taking a look to include some? Not vital, just a thought. It could be useful to point out that this is a wider problem and so place your paper in a wider context.

*Surprisingly, we struggled to find much literature on this topic (that is not included in the main text) and the section does not actually address the use of video games in a pedagogical setting, but addresses the portrayal of evolution in video games. We have added some extra references where video games have been used as teaching aids where appropriate such as Poli et al 2012.*

Line 447: Such an important observation!

*Thanks!*

Line 452: I think a summarising statement of the ways in which it is skewed would be useful. e.g. 'Other ways in which evolution can be misconstrued are depicting it as linear, oversimplified, or directional with a goal (usually of humankind).' This signposts the rest of this section.

*We agree that this section could be better signposted. We have re-jigged the intro to read: 'Evolution' is a common theme in video games, but while video games are potentially a great way to introduce players to the complex process of evolution, it should be remembered that COTS games must prioritise delivering engaging gameplay far above educational content. It should also be noted that the term 'evolution' is commonly used in video games to encompass a host of different game mechanics that do not accurately represent the biological process, potentially skewing the player's understanding of the phenomenon.*

Line 510: Would be good to reference this paragraph, you probably know more of the literature about this than I do! But perhaps starting points could be: Jones, E.D., 2018. Ancient DNA: a history of the science before Jurassic Park. *Studies in history and philosophy of biological and biomedical sciences*, 68, pp.1-14.

Attwood, A.I., 2021, September. A Perspective on the Educational Psychological Value of Jurassic Park and Similar Films for Bioethics Discussions. In *Frontiers in Education* (p. 345). Frontiers.

*Agreed, we have added a reference here. We feel that the references provided here are not appropriate for this section - but they are really useful in the bioethics section and so we have incorporated them in other areas of the manuscript!*

Line 539: This sentence stuck out, the language doesn't match the rest of the paper, maybe too colloquial. Maybe rephrase, or merge with following sentence e.g. 'unlike other traditional media, modern PC and (most) game consoles are connected to the internet...'

*Ok! We have made your suggestion and merged the two sentences. They now read:* However, unlike other traditional media, PC and (most) game consoles are connected to the internet, meaning game developers (and even fan communities) can issue updates and 'mods' (modifications) that update gameplay, graphics, or visual assets indefinitely after the games are released. Therefore, new fossil discoveries can be incorporated into game updates to keep games scientifically up-to-date.

Line 537: I think I commented earlier about whether to use the first person for sci commers rather than the authors of this paper

*See above. Agreed. We have removed this.*

Line 540: This section seems a bit sparse. I realise that's because some of what might be in here is in the following section on ethics, but I wonder if you might expand this section a little to include some info about the realises [sic] of fieldwork (those reading this without experience of fieldwork may not know what you are getting at). You could also at least signpost the ethcs [sic] of commodification and exploitation here before expanding them subsequently.

*We have added a sentence segwaying into the ethics of field work as requested.*

*We have also added to and re-worded part of the text to incorporate the points raised here:* Because fossil extraction is so common in video games, it can give the impression to players that fossil extraction is effortless, unmethodical, and skill-less – quite the opposite of the time-consuming, laborious, and often hazardous excavations that are often required to extract fossils.

Video games can also create the incorrect perception that fossils are a common occurrence in all types of rocks and that a destructive approach is required to extract fossil material. This can be problematic as it may not be obvious to amateur fossils hunters that using hammers on rocks at fossiliferous rock faces may cause irreparable damage, be potentially dangerous, and in some areas illegal. Recently, local government organisations have started to introduce ethical rock collection policies (see Scottish Geodiversity Forum 2017) which can be disseminated to the public by science communicators.

Line 571: Really good point!

*Thanks!*

Line 573: You should briefly mention the best practice in the real world for fossil collection and acquisition. For anyone reading this who is not involved in palaeontology, they may not understand what the problem is with some of these depictions because they don't know how fossils are supposed to be ethically acquired or studied.

*Good point. We have expanded the first section to more clearly outline the issue:* While finding and collecting fossils is an integral part of the enjoyment of palaeontology and is important scientifically, one of the most contentious ethical issues facing palaeontology is

the buying and selling of fossils (Shimada et al. 2014). The commercialisation of fossil material, especially over the internet and in high-profile public auctions (Shimada et al. 2014), directly leads to a myriad of issues including the destruction of fossiliferous sites by illegal fossil hunters (Murphy, 2007), samples being lost to science (Shimada et al. 2014), and in the worst case, the illegal exportation and smuggling of fossil material (e.g., Pérez Ortega, 2021) – and the consequences of this illicit trade e.g. fuelling humanitarian crises, such as in Myanmar (Dunne et al. 2021; Raja et al. 2021). There is increasing awareness of the problems of fossil commercialisation, yet, in virtually every game featuring fossils as collectibles, excess fossils exist purely to be sold for profit.

Line 612: It might be worth mentioning that scientists are often depicted as the 'bad guys' in all types of entertainment. They are often shown as being so obsessed with their science that all other ethical and moral considerations are not important. The depiction of palaeontological science is therefore falling into this tired trope. Some potential refs could be:

[https://www.tandfonline.com/doi/abs/10.1080/0263514032000127220?casa\\_token=Dyqw8tXErPwAAAAA:7DoNMbPWHKJnPQqi6jHtR9ioVSZWAtY3uwBBysrnnIWi2DL7C1NS3PIQoSqyswTyLnaLoQ5NNOs](https://www.tandfonline.com/doi/abs/10.1080/0263514032000127220?casa_token=Dyqw8tXErPwAAAAA:7DoNMbPWHKJnPQqi6jHtR9ioVSZWAtY3uwBBysrnnIWi2DL7C1NS3PIQoSqyswTyLnaLoQ5NNOs)

or

[https://journals.sagepub.com/doi/abs/10.1177/0963662503123006?casa\\_token=FYRMIYtMFBAAAAAA%3AkK2Zh9gtV9ePoGJ1HZMPG\\_neV82CuZPUq6kHDc1YT4s-zyhDSNenoTeYV8eW7zu5bdrP58-2x7Q&](https://journals.sagepub.com/doi/abs/10.1177/0963662503123006?casa_token=FYRMIYtMFBAAAAAA%3AkK2Zh9gtV9ePoGJ1HZMPG_neV82CuZPUq6kHDc1YT4s-zyhDSNenoTeYV8eW7zu5bdrP58-2x7Q&)

and I believe there are some specifically looking at these issues in the Jurassic park franchise.

*These are great references - thank you! We have added some text to make you well founded point:* After the player collects a number of fossils from across the game world to help her with her research, she assembles a biologically impossible chimaera, and reveals herself to have been a terrible scientist all along – the game falling for the classic trope of the unethical genius (see Weingart et al. 2003).

Line 637: Definitely need to ref this statement - you can use refs outlined elsewhere.

*Done*

Line 659: Really important point.

*Thanks for this comment.*

Line 664: Question about first person again (see other comments)

*Agreed - we have corrected this sentence so it reads:* Care should be taken by scientific communicators to not disseminate these damaging tropes if using video games as part of their engagement, and also take further action by actively highlighting and challenging these practises within palaeontology themed media.

Line 666: I think you should suggest some further research, for example into whether video games do in fact influence people's perception of how evolution works or

palaeontology and science is carried out. It might also be useful to incorporate this reference, especially in discussion of the use of gaming for education, and for understanding evolution and natural selection specifically:  
<https://www.learntechlib.org/p/148246/>

*Thanks for this comment - we have re-written a section of the conclusion to take account of this comment which now reads: Many COTS video games contain elements of good science communication — and some games, especially dinosaur simulators, strive for scientific accuracy. Indeed, aspects of many palaeontological themed COTS video games can be used by science communicators to highlight, engage, and educate the public regarding core concepts of palaeontological science.*

*While we do not think that adding references to the conclusion is necessary, we have incorporated the excellent reference you include here several times through the text, including altering a section of the introduction: Many COTS games impart complex scientific and historical content to their audiences by presenting the topic within fun and engaging game mechanics in a non-scholastic format (see Herrero et al, 2014; Crowley et al. 2021) and can be used as a tool within a wider educational framework (Herrero et al, 2014).*

Line 678: I assume you want to use the first person in this way? You might want to consider changing to the third person ('Science communicators should undertake...'). But this is a style choice,

*Amended as suggested*

Line 680: First person - see other comments

*Amended.*

Line 838: These are out of order with one another and rest of refs.

*Fixed - thanks.*

Line 878: Is this format correct? The rest of the refs seem to have a different format.

*This is a news article from Science, not a paper, so the reference is in keeping with the format used. I will flag with the editors.*

Line 904: Is the formatting correct for this? The date is at the end of the other refs, and the link should be highlighted.

*Fixed, thanks.*

Line 976: Number before alphabet, so this should come before Jurassic Park Builder I think?

*Fixed. Thanks.*

## **Figures:**

Figure 3:

Suggest changing this from [sic] 'No dinosaurs' to 'Other extinct animals' or similar.

*Done*

This figure shows that you've got data and metrics, but there is very little quantitative data in the manuscript. I realise some of this is in the supplementary excel file, but I also didn't understand exactly what I was looking at in the supplementary - what is the score? Apologies, it's probably my ignorance, but if I don't know then perhaps others will also not know. I suggest adding something in the supplementary file to explain these data, particularly what the 'score' refers to.

*Thanks for pointing this out - we have removed the score lists from the supplementary data – it was not utilised in the final manuscript. In accordance with your previous comments, we have included more data into the manuscript .*