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Comment on gc-2021-15

Anonymous Referee #2

Referee comment on "Introduction to teaching science with three-dimensional images of dinosaur footprints from Cristo Rey, New Mexico" by Valeria V. Martinez and Laura F. Serpa, Geosci. Commun. Discuss., https://doi.org/10.5194/gc-2021-15-RC2, 2021

Dear Editor,

I was asked to review the article authored by Martinez and Serpa entitled "Introduction to teaching science with three-dimensional images of Dinosaur footprints from Cristo Rey, New Mexico".

The article describes the merits of introducing digital representations of dinosaur foot tracks to lower level secundary school classes and lower level university classes. The argument are that of commodity and accessibility. In addition, the authors pleade for preserving digital archives of non-renewable fossil resources which are exposed to human and natural degradation. The obvious structure to preserve this knowledge is with local museums which both engage with the public and have a duty in preserving fragile evidence of the past. Finally, the authors evoke their field practice for acquiring digital photographs and producing accessible 3D models. All these intentions are very valuable, especially when access to the field is prevented by the present-day Covid-19 pandemic. The argument of engaging with a public wider than specialists is definitely one of the moral duties of science communicators and earth science academics.

My overall impression is that the paper, while revolving around a topical subject, lacks sharpness along two axes. (i) Teaching aims at transmitting specific knowledge and skills. For that, a wide range of communication methods could be employed to convey the messages so that the audience not only receives the information but also understands the meaning of the message, integrate it to their reasonning and reuse this new knowldge appropriately. (ii) 3D landscape digitization using structure-from-motion has now been largely published about in the scientific litterature in the last decade. The authors appear to have missed the abundant literature evoking practicalities of shooting photographs for optimal SFM results in the earth sciences. A last peripheral point, the authors appear unaware of all the techniques that could have enhanced the 3D rendering of the dinosaur footprints in their figures.

In order to improve a new submission, I would suggest that a discussion of key skills and reference knowledge is presented in introduction of the article. That is, listing and describing the essential reflexes a beginning paleontologist is expected to have or acquire. What skills should they acquire by the end of the class and by the end of the course ? How could these teaching objectives be reached, when the spectrum of tools at hand are

truncated by a pandemic context (i.e. field access is prohibited)? A discussion focused on which aspects of 3D digital file manipulations can lead learners to grasp, integrate and reuse taught concepts appropriately. How do digital tools really address these needs? It may be that they are no more than eye catching, which is great to engage a lesson. But they could be a lot more. Or on the contrary, there are many cognitive aspects that do not require distracting 3D repesentations. And further, many software do not provide the essential information easily off the box. This is where this contribution could be valuable. This is a venu to explain how these critical pieces of knowledge could be made available to the public using standard tools. The merits of data format and aspects linked to computer burden could also be discussed as they are additional hurdles hampering the use of 3D representations in a remote class room.

Concerning photogrammetric acquisition, I would strongly recommend that the authors consult easily accessible papers. For instance: Wenzel, K., Rothermel, M., Fritsch, D., Haala, N., 2013, Image acquisition and model selection for multi-view stereo, Int. Arch. Photogramm., Rem. Sens., and Spat. Inf. Sci., XL-5/W1, p. 251-258. They describe the recipe for optimal photogrammetric acquisition in the field. Two motos: "one panorama each step" and "one step every 1/5". As a first key reading, I would say that their table 3 and 4 contain all there is to know for producing excellent results with far less photographs than were shot.

Good photogrammetric practices are further detailed in James et al, 2019 (ESPL https://doi.org/10.1002/esp.4637). Following their recipe warants bullet-proof acquisition methods and will meet publication standards. Having these publication standards in mind, the technical photogrammetric descriptions given in this contriution appears indeed very (too) short.

As for visualisation, the human eye is most sensitive to greyscale variations. Figures should adopt so sort hillshading. Representations made with Cloud Compare could either activate "EDL" (Eye-dome_lighting) to enhance local relief or compute normals (Edit > Normals > Compute with an appropriate radius of 1 cm, for instance) will reveal local gradients. It may also be that computing "PCV" (Portion de Ciel Visible, a uniform shading algorithm to enhance exposed or depressed areas) further reveals details. Note that RGB point cloud displays can technically be displayed simultaneously with normals activated and EDL switched on. It may however not always produce the most legible result. And finally, to enhance the depth of a footprint, computing a smooth surface fitted to ground level and a cloud2mseh distance, will enhance foot depressions in the surface. From this, one could wonder whether all footprints from the same individual depressed the surface in the same way. The cloud2mesh distance will provide a quantified metric.

As for colour ramps (those of figure 7 are rather poor for perceiving 3D information), two recent references discuss the design of perceptually uniform colour ramps: Peter Kovesi (https://colorcet.com/) and Fabio Crameri (https://www.fabiocrameri.ch/colourmaps/). Note that Peter Kovesi build colour ramps for Cloud Compare (check the dowload section of the site). Colour ramps for QGIS exist with both authors.