



# Enhancing Heritage: 3D Modeling Technologies in Australian Higher Education

**Robert Stephan**  based on peer reviews by **Mike Yeates** and 1 anonymous reviewer

Thomas J. Keep, Madeline M. G. Robinson, Jackson Shoobert, Jessie Birkett-Rees (2025) An Australian Overview: The Creation and Use of 3D Models in Australian Universities. Zenodo, ver. 2, peer-reviewed and recommended by Peer Community in Archaeology. <https://doi.org/10.5281/zenodo.13864694>

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The integration of 3D modeling technologies in Australian universities is transforming the study and preservation of cultural heritage, providing innovative ways to enhance educational outcomes and accessibility. This article by Keep et al. meticulously explores how these digital tools are being adopted across various institutions to support object-based learning (OBL) and research.

This paper delves into the significant rise of 3D digitization in cultural heritage, driven by the increasing availability of advanced, user-friendly technology. By examining the methodologies employed by major Australian universities, the authors present compelling evidence of how 3D models serve not just as substitutes for physical artifacts but as enhanced digital surrogates that offer new insights and educational opportunities. For instance, the University of Sydney and the University of Melbourne showcase projects where digital models allow for detailed examination of artifacts beyond what is possible in physical settings, demonstrating the practical benefits and pedagogical impacts of 3D modeling.

However, the article also highlights substantial challenges, including the lack of standardized practices and sustainable funding, which could impede the full potential of these digital surrogates. The variability in digitization and metadata practices among institutions suggests a pressing need for standardized protocols to ensure compatibility and maximize the utility of 3D models in academic and research settings.

One of the most compelling aspects of this study is its discussion on the future of digital methodologies in heritage studies. The authors advocate for strategic, long-term collaboration to address these challenges, suggesting that without a concerted effort to regulate and standardize 3D modeling practices, the benefits

of these technologies might not be fully realized. They call for a symposium similar to the London Charter, aiming to establish guidelines that could shepherd the growth and integration of 3D technologies in cultural heritage studies.

This recommendation for Keep et al.'s article is based on its insightful analysis and its potential to serve as a blueprint for other institutions looking to incorporate 3D modeling into their curricula. The detailed case studies and critical perspectives on standardization and sustainability provide a crucial viewpoint for future developments in this field. The article not only underscores the successes of digital surrogates in educational contexts but also addresses the limitations and challenges, paving the way for enriched academic discourse and practical applications in cultural heritage studies.

### **References:**

Thomas J. Keep, Madeline M. G. Robinson, Jackson Shoobert, Jessie Birkett-Rees (2025) An Australian Overview: The Creation and Use of 3D Models in Australian Universities. Zenodo, ver.2 peer-reviewed and recommended by PCI Archaeology <https://doi.org/10.5281/zenodo.13864694>

## **Reviews**

### **Evaluation round #1**

DOI or URL of the preprint: <https://doi.org/10.5281/zenodo.13864694>

Version of the preprint: 1

### **Authors' reply, 20 February 2025**

We thank the reviewers for their helpful feedback, and have made some small adjustments. Additional paragraphs have been added to the introduction and discussion sections to expand on the importance of standardisation and metadata recording to future-proof collections for potential AI assisted analyses. The additions are minimal, as a full discussion of these topic would merit its own paper (maybe a future follow up to this one!).

We have also corrected some formatting errors in the reference list, reduced the Melbourne University section, clarified "the position" in the UNE section, provided further suggestions for future collaborative work, and added practical examples to the paper.

If there are any further improvements you can suggest, we would be glad to hear them. Otherwise, we thank the reviewers and recommender for their help and guidance in this article.

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### **Decision by Robert Stephan , posted 16 December 2024, validated 16 December 2024**

As Reviewer 1 notes, these authors should be congratulated "on a clear and concise overview of how 3D models of cultural heritage artefacts are being used to support Object-Based Learning in several Australian universities." One of the paper's primary strengths is its comprehensive overview of the different 3D modelling techniques—such as structured light scanning, laser scanning, and photogrammetry—employed to enhance educational resources, public outreach, and research. The detailed discussion on how these technologies are implemented across various institutions to make teaching collections more accessible through Object-Based Learning (OBL) particularly stands out. This is critical in a time when online and hybrid teaching models are becoming more prevalent. Additionally, the paper adeptly addresses the broader implications of these

technological adoptions for condition management of collections, illustrating how enhanced 3D models provide new insights that surpass traditional methods. This not only improves educational outcomes but also enriches the preservation and understanding of cultural heritage.

Both reviewers note a small number of changes that would improve this paper even more. If the authors make these minor changes, this paper should be ready to be published.

### Reviewed by **Mike Yeates**, 27 November 2024

I congratulate the authors on a clear and concise overview of how 3D models of cultural heritage artefacts are being used to support Object-Based Learning in several Australian universities. This paper highlights several important issues in the capture, storage, and sharing of 3D models, in particular how 3D models are not treated with the same rigour and validity as 2D photography.

Please see below for specific suggestions:

- The introduction alludes to how the divergent approaches across different institutions could lead to future challenges in machine learning and big data analysis. This is an important realisation and I feel the impact and significance of this paper would increase if this idea were further explored.
- There is a disparate voice in the Melbourne University section which is far more technical than other parts of the paper. This paper seems to target a broad and general audience, so perhaps some footnotes explaining terms like UV unwrapping, diffuse textures, and normal maps would be worthwhile.
- The third paragraph of the University of New England section (lines 321-331) doesn't flow as well as the rest of the paper. Additional elaboration on "the position" and what it is exactly would boost clarity in this section.

### Reviewed by anonymous reviewer 1, 11 December 2024

Title and abstract

Does the title clearly reflect the content of the article?  Yes,  No (please explain),  I don't know

Does the abstract present the main findings of the study?  Yes,  No (please explain),  I don't know

Introduction

Are the research questions/hypotheses/predictions clearly presented?  Yes,  No (please explain),  I don't know

Does the introduction build on relevant research in the field?  Yes,  No (please explain),  I don't know

Materials and methods

Are the methods and analyses sufficiently detailed to allow replication by other researchers?  Yes,  No (please explain),  I don't know

Are the methods and statistical analyses appropriate and well described?  Yes,  No (please explain),  I don't know

Results

In the case of negative results, is there a statistical power analysis (or an adequate Bayesian analysis or equivalence testing)?  Yes,  No (please explain),  I don't know -NA

Are the results described and interpreted correctly?  Yes,  No (please explain),  I don't know

Discussion

Have the authors appropriately emphasized the strengths and limitations of their study/theory/methods/argument?  Yes,  No (please explain),  I don't know

Are the conclusions adequately supported by the results (without overstating the implications of the findings)?  Yes,  No (please explain),  I don't know

An Australian Overview: The Creation and Use of 3D Models in Australian Universities analyzes the methods, benefits, and challenges surrounding the development and digital storage of 3D surrogates across four distinct Australian universities. The authors begin by outlining the impact of the COVID-19 pandemic on the increase in digital surrogate production to enhance object-based learning practices for hybrid and online teaching. They outline how this instructional shift and absence of best practice guides created a vacuum for ad hoc model creation, leading to a disparity in model data management, specifically failing to take into account long-term implementation. To substantiate this claim, the authors expand upon the varied methods of 3D digitization and data storage utilized at the University of Sydney, the University of Melbourne, the University of New England, and Monash University. In their discussion, the authors clearly outline the need to standardize 3D modelling development and data storage practices for cultural heritage education in Australia through long-term planning and sustained financial investment. They conclude with the hope that 3D model generation for cultural heritage education will be prioritized in the near future.

This article is highly successful in outlining various case uses of software to develop and store 3D surrogates, specifically focusing on how different software and digitization processes were beneficial for specific projects. For example, Figures 2 and 3 provide a strong visual representation of how combining photogrammetry with multi-scale integral invariants produces more precise and detailed digital surrogates. This emphasis clearly shows the benefits of digitization software while also explaining how the sheer size of collected data and various ways to create digital 3D models has led to varied practices across institutions. Perhaps the most exciting component of this article is the authors' call for "an online Library of Alexandria". In other words, there is a call for widespread data sharing amongst Australian universities, allowing faculty and students across institutions to access, improve, and share digital surrogates. While this call to action would greatly benefit students and faculty across Australia, it is no small feat to develop and apply standard data storage management plans that would enable access for all.

As a practitioner of mixed reality (XR) pedagogy for cultural heritage education in the United States, I see the value of this article and agree with the main arguments presented by the authors. Similar to Monash University, the development and storage of mixed reality assets at my home institution is decentralized leading to ad hoc practices within one institution, never mind across multiple. For this reason, like the University of New England, we are also considering hiring a central staff or faculty member to support the administration and standardization of XR practice and instruction across the university. My experiences at an American university resounded with the arguments by the authors, leading me to believe that the findings of this paper are highly transferrable and representative of the larger state of immersive pedagogical design in higher education around the world.

I would only suggest minor edits to this manuscript as follows:

- The authors effectively show the need for a call to standardize the practice of developing and storing 3D surrogates across Australian universities. However, they do not provide guidance on how to proceed with the development of such a system. Perhaps the conclusion of this article would benefit from some preliminary suggestions about next steps to develop a standard system for 3D digitization practices or a platform on which to integrate data-sharing practices.
- The paper provides a clear and concise description of object-based learning but would benefit from providing some examples of the deployment of this pedagogical design in the section about OBL. There are some examples of the implementation of OBL throughout the article, but it might help the reader conceptualize how and why 3D models for OBL are beneficial to online and hybrid students if there are specific examples of their deployment in this section.

Overall, this is a well written article that adds to the larger academic conversation about the development and storage of immersive pedagogical materials for cultural heritage education.