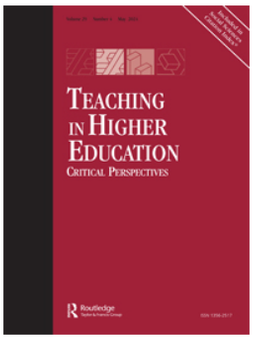

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From active learners to knowledge contributors: authentic assessment as a catalyst for students' epistemic agency

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ABSTRACT

This study examines how authentic assessment could nurture students' epistemic agency: their sense of agency in using, evaluating and producing knowledge. Authentic assessment commonly emphasises 'realism' and 'employability skills'. As important as these ideas are, this approach to authentic assessment neglects the key academic value of *knowledge*, a gap we address by adding epistemology into the conversation. Our qualitative case study explores an archaeology course whose authentic assessment design relied heavily on digital technologies. We empirically analyse students' sense of epistemic agency after articulating the affordances of the course's authentic assessment design. Our findings show that digitally-mediated authentic assessment promoted students' relationship with knowledge in three ways. Students understood themselves as (i) active learners, (ii) active users of knowledge and (iii) epistemic agents who contributed to public archaeological knowledge. We reframe authentic assessment as a catalyst for students' epistemic agency, enabling students to contribute to social good.

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Authentic assessment; epistemic agency; digital assessment; epistemology; student agency

Introduction

Our ways of engaging with knowledge have changed drastically in the increasingly digital societies. In the digital world, knowledge is easily accessible to anyone with digital technologies; the amount of knowledge is daunting and ever-increasing. Modern citizens must constantly evaluate the credibility of information within the contexts of post-truth politics, polarisation of knowledge, and artificial intelligence. This context challenges higher education to rethink its teaching practices in order to prepare graduates to operate purposefully and critically with knowledge in the unknown future (Välimaa and Hoffman 2008).

In this study, we focus on the role of digital assessment in supporting students' epistemic agency, namely, their sense of agency in using, evaluating and producing knowledge (Nieminen and Ketonen 2023). Assessment is increasingly digital (Crisp,

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Guàrdia, and Hillier 2016), but assessment practices have nevertheless not kept pace with the digital world (Bearman, Nieminen, and Ajjawi 2023). Assessment has largely not acknowledged the changing demands of the Fourth Industrial Revolution. Instead of reforming the very purposes of assessment, digital technologies have mostly complemented the existing structures of assessment (Timmis et al. 2016; Slade et al. 2022). Moreover, research has emphasised that digital assessment should not only be 'innovative' but transformative in the sense of promoting students' agency as responsible citizens who shape – rather than reproduce – the world around them (Nieminen, Bearman, and Ajjawi 2023).

We explore one particular type of assessment in promoting students' epistemic agency: authentic assessment. Authentic assessment refers to assessment tasks that 'use the same competencies, or combinations of knowledge, skills, and attitudes, that they [students] need to apply in the criterion situation in professional life' (Gulikers, Bastiaens, and Kirschner 2004, 69). It is often promoted as an active, experiential form of assessment (Reynolds and Kearns 2017). While authentic assessment has received considerable scholarly attention (Ashford-Rowe, Herrington, and Brown 2014; Villarroel et al. 2018), the role of digital technologies has not received adequate attention in this literature (Nieminen, Bearman, and Ajjawi 2023). Simultaneously, authentic assessment literature has rarely considered 'authenticity' from the viewpoint of *knowledge*. Instead, research has largely focused on skills, competencies and employability (Sokhanvar, Salehi, and Sokhanvar 2021). This is an important research gap in higher education, where academic knowledge should arguably be put at the centre of assessment (Shay 2008).

This study examines the affordances that digitally-mediated authentic assessment provides for students' epistemic agency and the realisation of these affordances in students' experiences. We report an in-depth qualitative case study in archaeology. In the course, the students used authentic archaeological datasets to produce a 3D model of an ancient site. The students then created a Wikipedia article about their site and thus made real contributions to science and public knowledge (Evenstein Sigalov and Nachmias 2023). In doing so, the students used authentic digital technologies to preserve and share cultural heritage. The context of archaeology provides an intriguing discipline for our study, given its unique knowledge structure that draws on both positivist forms of knowledge production and sociocultural approaches that emphasise human interpretation and cultural knowledge.

Theoretical framework: epistemic agency

Agency is a traditional sociological concept that has been used to denote human agency amidst wider social and societal structures (Archer 2000). Student agency – one's ability to act meaningfully and autonomously in society – is commonly portrayed as an important graduate outcome in higher education policies and practices (Jääskelä et al. 2021). While student agency has been increasingly examined in assessment literature (Stenalt and Lassesen 2022), the concept has so far remained largely underdefined in assessment (Adie et al. 2018; Nieminen et al. 2022).

We focus on an epistemic form of agency. The concept of 'epistemic agency' has been used across the literature with varied and often conflicting paradigms (Miller et al. 2018), including across the higher education literature. In school-level studies on knowledge-

building activities (Scardamalia and Bereiter 1991), epistemic agency has been introduced as a sociocognitive construct that emphasises students' responsibility to 'take control and ownership of their own processes of learning and inquiry' (Odden, Silvia, and Malthe-Sørenssen 2021, 5; see also Stroupe 2014). Damşa and colleagues (2010) described epistemic agency as having two dimensions in the higher education context: a knowledge-related dimension (e.g. sharing and producing ideas) and a regulative dimension (e.g. setting and monitoring goals).

We depart from these definitions by conceptualising epistemic agency as a sociopolitical concept rather than merely as a cognitivist-affective one. Epistemic agency then refers to agency with respect to academic knowledge to human agency in learning, evaluating, transforming, and using knowledge (Miller et al. 2018; Nieminen and Ketonen 2023). It focuses on 'the type of agency that can lead to knowledge-related outcomes and innovative ideas' (Yang and Markauskaite 2021, 4). By participating in activities that nurture epistemic agency, students may see themselves as epistemic agents, such as 'productive participant[s] in knowledge-laden activities' (Heikkilä et al. 2020, 2).

We take a critical realist position on knowledge by recognising that knowledge has 'an identity distinct from knowers and knowing' (Shay 2008, 603). Even then, the critical realist position acknowledges that knowledge is always socially produced and mediated. This approach can accommodate disciplinary differences in authentic assessment, as the notions of 'knowledge' and 'knowing' differ greatly in different contexts. Disciplinary knowledge structures are necessarily reflected in authentic assessment. Authentic assessment is different in law, natural sciences, creative arts, and social sciences not only because of different cultures or norms but also because of how the very central idea of knowledge is understood. For example, as Nieminen and Lahdenperä (2021) note, exams and quizzes might adequately fit 'hard' sciences in which knowledge is considered to exist separately from the knower – they might thus be considered to be 'authentic'. Likewise, in 'soft' disciplines such as creative arts, assessment criteria and practices may be influenced more heavily by the 'knowers' themselves (Pitt and Carless 2022).

Epistemic objects are central to the development of epistemic agency. Epistemic objects are the material outcomes of knowledge construction processes (Miller et al. 2018; Muukkonen et al. 2011; Yang and Markauskaite 2021). Although knowledge objects are commonly produced in assessment tasks – exams, essays, group projects – the purpose of these objects tends to be framed from the viewpoint of learning. It is rare to encounter authentic assessment practices that prepare students to produce knowledge objects with a meaningful contribution to social good (McArthur 2023; Nieminen, Bearman, and Ajjawi 2023). Such meaningful knowledge objects may have a transformational effect on students when their productions impact the wider society. This transformative element captures the ever-changing nature of academic knowledge, allowing epistemic agents to critically contest existing knowledge when necessary (Nieminen and Ketonen 2023).

Epistemic agency highlights the connection between the individual learner and the wider societal structures of authentic assessment. We do not see epistemic agency as something that individual students possess. Instead, epistemic agency is the outcome of students' transformational relationship with knowledge (Ashwin 2014, 2022). It can be observed by examining students' positioning in relation to knowledge. In this view, assessments can be designed not to promote assessment but to provide affordances for agency (Nieminen and Tuohilampi 2020). The concept of affordance has been used

widely in research on educational technology with varying definitions and ontological presumptions (Hammond 2010). We refer to affordances as the functional potentials of authentic assessment design for promoting epistemic agency, following the conceptualisation of Osborne and colleagues (2013). These affordances are then perceived by students who may use them to develop their epistemic agency – or not.

Authentic assessment in the digital world

Using a precise conceptualisation of digitally-mediated authentic assessment, we analyse the assessment design of the course involved in our case study. We rely on the four-fold conceptualisation of the *purposes* of authentic assessment from Nieminen, Bearman, and Ajjawi (2023): why should the digital be designed into authentic assessment?

First, digital technologies are used to *enhance authentic assessment design* by making it more efficient and pedagogically rich. Such approaches might widen authentic assessment to consider both summative and formative assessment (e.g. Balderas et al. 2018; Moore 2018). The second purpose considers *developing and credentialing digital literacies*. Authentic assessment may teach students to use the relevant digital technologies they will need in their future profession (e.g. Esterhazy, Lange, and Møystad 2021). Here, credentialing refers to the official recognition of students' digital literacies through summative assessment, such as by recognising these as a part of students' grades and diplomas. Third, digitally-mediated authentic assessment may *develop and credential human capabilities for a digital world*. This means that authentic assessment may focus on the uniquely human capabilities that could not be completed by digital technology itself (e.g. AI or robots). In doing so, authentic assessment may develop students' sense of the self in the digital world. Finally, digitally-mediated authentic assessment may *foster communality* by reaching beyond the boundaries of academia. For example, authentic assessment could use digital technologies to promote social good in society. These four purposes provide us with an organising framework for understanding *why* the digital should be designed into authentic assessment.

Following the criticism of McArthur (2023), we do not only see authentic assessment as a tool to promote skills and agency needed in the world of work (see also Vu and Dall'Alba 2014). We position authentic assessment in its wider context of employability and market-driven discourses in higher education (Serrano et al. 2018; McKenna 2022). As Wheelahan and colleagues (2022) argue, knowledge has increasingly been downplayed amidst the focus on employability skills (see also McKenna 2022). To reach its full potential in higher education contexts, authentic assessment must consider 'authenticity' from the viewpoint of epistemic agency. The concept of epistemic agency enables us to analyse how authentic assessment teaches students through their experiences of critically evaluating, comparing, applying and creating knowledge in digitally-mediated ways. In doing so, authentic assessment may better connect assessment with the digital society as it educates students to be responsible citizens in their digital futures.

Research objective and significance

Our study examines how authentic assessment could nurture students' epistemic agency through a case study in an undergraduate archaeology course. We address two research

questions that build upon each other. First, we sought to understand how authentic assessment was *intended* to promote epistemic agency. We analysed the course syllabus, undertook classroom observations, and engaged in multiple teacher interviews to answer the following research question:

> RQ1) How did the assessment design reflect the purposes of digitally-mediated authentic assessment? What were the affordances for epistemic agency that this assessment design provided?

RQ1 widens our understanding of the opportunities that authentic assessment provides for students' epistemic agency. As such, it directly addresses the under-conceptualisation of knowledge and knowing in the context of authentic assessment.

Second, we examined how those affordances were realised in students' experiences. RQ2 contributes to the empirical evidence base on how assessment could develop epistemic agency. Through this case study, we thus considered our second research question:

> RQ2) What was the students' sense of epistemic agency during and after the course? In students' experiences of agency, what were the stated enablers and hindrances for epistemic agency to occur?

Our two research questions are rather different. The first one ultimately leads to a list of affordances, whereas the second one requires an in-depth analysis of how students used these affordances. As such, the second research question presents the main empirical analysis of our study.

Research design and methods

The case study

We followed a qualitative case study design to examine the abstract theory of epistemic agency within a contextual case (Yin 2018). The target discipline of this study was archaeology, an interdisciplinary field that straddles the social sciences and humanities. Archaeologists examine material remains – architecture, pottery, technology, landscapes, material culture – to investigate societal developments of the human past. Archaeology provides a particularly fruitful context for our study due to its diverse knowledge structure that draws on both positivist, science-driven methods as well as interpretivist, sociocultural frameworks (Cobb, Cobb, and Azizbekyan 2022). Within the digital humanities, archaeology is also unique due to the wide variety of digital data types used, from 3D models of spaces and objects to satellite imagery to textual descriptions of excavation processes and beyond.

Our case study focused on the undergraduate course 'Emerging Societies: an Introduction to Mesopotamian Archaeology', which was taught at a research-intensive university in Hong Kong in Spring 2022. The course lasted four months, with 17 officially registered students and two additional dedicated auditors. The course's learning outcomes spanned students learning the basic ancient evidence and understanding introductory archaeological methods and theories to consider the social, economic, and political implications of the material in the past and the impacts of cultural heritage on the present.

The course was structured as a flipped classroom. This structure gained added significance when the university pushed teaching online during that semester due to the

COVID-19 pandemic. The meetings were held on Zoom. The students were asked to carry out assigned readings before each class in a collaborative discussion format through an online platform called Perusall (https://www.perusall.com/). Perusall provides a platform for group annotations of both texts and videos. The students were encouraged to ask questions that could be answered online without taking class time and to start conversations about topics they found interesting.

An additional teaching experiment was undertaken during this course in the form of group Virtual Reality (VR) remote tours during four tutorial sessions. Each student used a VR headset at home to join a tour where the instructor guided the group around a virtually reconstructed ancient site. The goal was to improve spatial understanding of the sites (for a full account, see Cobb and Nieminen 2023).

The main assessment in the course, worth 35% of the final grade, was a research project on an ancient site in Mesopotamia. Student groups researched the site, and then individual students spent much of their time building a 3D reconstruction model of some small section of the site, such as an architectural feature. The goal was for students to learn to work with authentic archaeological data while analysing and interpreting a site just like a real archaeologist. 3D modelling forces students to think about the evidence and possible interpretation of each part of the building since each part must be precisely built in the software. An undergraduate course tutor from the humanities supported the archaeological research, and a course tutor from architecture helped with 3D modelling skills. Finally, each student also wrote a short addition to the public Wikipedia entry about their site and uploaded pictures of their 3D reconstruction – the knowledge object (Evenstein Sigalov and Nachmias 2023). All other teaching and assessment practices supported and scaffolded the development of this knowledge object.

Each student kept a reflection journal, following guiding prompts. This journal trained students to report their thinking and decisions like authentic log journals kept at archaeological sites. The first prompt asked the students to build an annotated bibliography of relevant references, and the subsequent ones asked them to reflect upon their group and individual work processes. Two closed-book quizzes (15%) and a final test (20%) contributed to the grade. The final 30% of the grade consisted of participation in the lectures, Perusall conversations about the readings, and tutorials.

Data sources

To provide a rich contextual account of our case, we relied on various qualitative data sources (Yin 2018). We introduce our datasets in Table 1. The project received human research ethics approval from the university. Due to anonymity issues, we do not provide background information about the participating students.

Data analysis

All the data were coded into analysis units that consisted of one meaningful set of utterances. These codes usually consisted of 2–3 full sentences. We combined two coding methods, descriptive and in vivo, using the participants' exact words (Saldaña 2021). The latter one was particularly used for RQ2 as we tried to understand the student experiences.

Table 1. The data sources and the volume of the primary data sources.

RQ	Data source	Description of data	Volume of data source
1	Syllabus and other documents	The syllabus and other relevant documents were (e.g. course Moodle site).	Approx. 15 pages.
	Interviews and conversations with the teacher	The first author had multiple informal conversations with the teacher (the third author) throughout and after the course. Many of these conversations were audio-recorded. After the course, the three authors gathered in a reflective interview session.	Approx. three hours of recorded conversations.
2	Post-course interviews with students ($n = 4$)	An invitation to participate was sent to all students. The interview protocol asked the students to share their experiences of each of the course elements.	43–52 min.
	Critical incident interviews ($n = 5$)	To supplement the four previous interviews, we sent an invitation to the remaining students who had not participated in the first interview four months after the course had ended. These interviews captured the students' critical incidents: their key learning experiences that still felt relevant after time had passed.	14–60 min.
	Student journals ($n = 12$)	12 students produced a multimodal journal with four guided entries.	Approx. five pages each, 60 pages in total.
	Open-ended survey data ($n = 14$)	An open-ended survey was collected before and after the two quizzes and the final test. The pre-survey asked about how the students had prepared for the test and why; the post-survey asked about their experience and emotions afterwards. Fourteen students provided these responses.	3 * 14 = 42 responses, approx. 15 pages.
	Knowledge objects (*supplementary data*)	The final 3D models, the draft versions, the final Wikipedia entries, responses to quizzes and the final test.	-
	In-depth interviews with one student group (*supplementary data*)	One voluntary student group was interviewed three times about their group work process (20 min each). Their online collaboration in Zoom was also recorded.	-
	Classroom observations and lecture recordings (*supplementary data*)	The first author observed the lectures of the course. After the COVID-19 lockdown, the lectures were turned online. Each of the subsequent lectures was recorded.	Five field notes from the lectures (approx. two pages each), six recorded lectures (two hours each).
	Online discussions in Perusall (*supplementary data*)	There were 42 reading materials (e.g. brief articles and videos). Each of these had approximately 10–20 comments, some of which sparked longer conversations.	–

To address RQ1, we conducted a theory-driven qualitative content analysis (QCA) (Schreier 2012). First, we analysed how digital technology was used in authentic ways in the overall assessment design. We categorised the codes according to four purposes of designing the digital into authentic assessment: (1) better assessment, (2) digital literacy, (3) sense of the self and (4) communality (Bearman, Nieminen, and Ajjawi 2023; Nieminen, Bearman, and Ajjawi 2023). We then conducted the QCA process to the same codes to determine how the assessment elements provided affordances for students' epistemic agency. We used our background theory on epistemic agency as a guiding framework.

RQ2 was addressed through an inductive, data-driven analysis of student positioning in relation to knowledge. Our qualitative analysis captured students' *sense of epistemic agency*. This is an important differentiation from direct analyses of agency. Most studies on student agency focus on practical actions as enacted in assessment. This approach often neglects the nuances of how agency is experienced (Nieminen and Hilppö 2020). An analysis of students' sense of agency acknowledges that people's accounts of their agency do not always fully represent what they have done in practice. It builds a conceptual distinction between people's actions (agency) and their reflections on these actions (sense of agency). We first focused on students' accounts of their epistemic actions: how they explained learning and studying as they progressed in the course. We then analysed how these actions reflected students' *orientation to knowledge*: how they positioned themselves with respect to knowledge in digitally-mediated authentic assessment (Nieminen and Hilppö 2020).

The supplementary datasets were used throughout the analysis to confirm and contest the findings. The analysis was collaborative in the sense that we engaged in various research meetings to test and develop our interpretations. In the next few sections, we have provided various data excerpts to enable the reader to contest our interpretations. These data excerpts have been edited slightly for readability.

Findings

RQ1) Affordances for epistemic agency

We introduce the findings regarding RQ1 in Table 2.

In summary, the four purposes of authentic assessment were identified in the content analysis of the syllabus and the teacher interview. First, the course syllabus drew on **digital tools for better assessment** that enabled the learning of knowledge and skills that were essential for creating the authentic learning object. Additionally, the digital tools promoted student collaboration in understanding and reflecting on the written and 3D knowledge in the field of archaeology. Second, the teacher described aspects of the digital tasks to enhance the students' **digital literacy**. The students were asked to master some authentic digital technologies as they progressed on the course. These digital literacies enable knowledge construction and communication in the profession of archaeology. Third, the teacher described the aim of **developing human capabilities** through enhancing student collaboration and teacher-student discussions on the articles that served as the reading material. Importantly, the teacher emphasised the tasks aimed at promoting the students' professional identity. Fourth, the course aimed at enhancing **communality** through the creation and publication of the authentic knowledge object.

RQ2) Students' sense of epistemic agency

Three modalities of sense of agency were analysed. These modalities represent a different positioning with respect to knowledge.

Sense of being an active learner

Any person requires knowledge to wield epistemic agency, but the type and amount of such knowledge depends on one's domain context. The students needed to learn a list

Table 2. The affordances of the digitally-mediated authentic assessment design for epistemic agency.

Purpose	Assessment element	Affordances for epistemic agency	Data examples
Digital tools for better assessment	Readings in Perusall • Promotes in-depth reading and collaboration • Helps to manage that all the students have done their reading Quizzes and final test • Helps to assess facts that are to be retained • Efficiency of digital tests with multiple choice questions Wikipedia entry • Multimodality and authenticity enhance the quality of learning • Requires deep content learning Journal • Multimodality enhances the validity of grading • Promotes reflection and self-regulation	Validates and certifies students' knowledge of facts, principles and skills Authentic assessment promotes learning which enables creating the authentic knowledge object Introduction to the epistemology of archaeological knowledge Promoting student collaboration on understanding and reflecting on the 3D and written knowledge in the field of archaeology Experiential learning promotes students' understanding of archaeology	**3D modeling aimed to promote experiental learning:** 'There is one advantage that the actual site does not currently give, is the ability to see the reconstruction. You can actually go into the temple and not just walk around its foundations. With VR, we hope that that kind of experience is even better'. (Teacher interview) **Quizzes and tests aimed to promote learning:** 'So that would force them to memorise things, which I think is useful, to have some basic knowledge, some basic information, facts that you can play with'. (Teacher interview)
Digital literacies	3D site modeling • Learning the authentic modeling and drawing software Wikipedia entry • Usage of the Wiki platform is a part of the profession Journal • Learning multimodal communication via journaling	Archaeological knowledge construction requires digital literacies regarding professional tools, which can be taught through authentic assessment Introduction to the digital ways of communicating archaeological knowledge	**3D modeling aimed to promote authentic digital literacies:** 'My imagination was that they would go out and use this as a skill in the field where they would do a reconstruction or something'. (Teacher interview) **The Wikipedia entry aimed to promote authentic digital literacies:** 'I had asked them to talk about its function in the ancient world of this space. Which usually is interpreted by the original archaeologist, so you know, setting up an account, doing an edit using the Wikipedia page, these are all skills that I think they should develop'. (Teacher interview) **Journaling aimed to promote authentic digital literacies:** 'So, it is typical that archaeologists will write a narrative during their working day and we do it using Evernote on our phones. You know, the person who's running the trench'. (Teacher interview)
Human capabilities	Readings in Perusall	Experience of creating a knowledge object through one's own persona	**3D modeling aimed to promote spatial thinking:** 'And so the goal with the VR is to, by having

(*Continued*)

Table 2. Continued.

Purpose	Assessment element	Affordances for epistemic agency	Data examples
	• Student collaboration on reflecting on the articles • Teacher-student discussions 3D site modeling • Spatial thinking • Creativity • Critical reflection • Data literacy Wikipedia entry • Confidence in the ability to communicate with the public community • Finding one's voice as a science communicator Journal • Developing students' voice and professional identity	Self-confidence as a part of professional development Development and communication of one's professional identity through epistemic reflections	this embodied interaction with the space, that you will take away a better remembrance of what, where everything is. The ability to think through like a sculptor means that you think about an object and then make it in three dimensions, right?' (Teacher interview) **3D modeling aimed to promote data literacy: '**You have to first be able to just take out the two-dimensional data and make that into 3D and as part of that there's an interpretation which goes on, doing the archaeological interpretation, based on the limited evidence'. (Teacher interview) **3D modeling aimed to promote a sense of the self:** 'There's a desire to see they created something so that they could, you know, come out with a product that they have themselves built'. (Teacher interview) **Journaling aimed to promote a sense of the self: '**They can just communicate what's on their own mind. I feel like it's a more enjoyable activity. And one that should take less effort and time, but also one where they can be themselves to a certain extent, right. So in a research paper, you're writing in a certain way, it's not yourself that's coming through'. (Teacher interview) **Perusall aimed to promote collaboration:** 'What I can see is that a student will like, for example, ask a question or make an interesting observation. And these things I can respond to. Other students can respond to them as well'. (Teacher interview)
Communality	Wikipedia entry • Contributing to public knowledge	Creating and sharing an authentic knowledge object Reserving cultural heritage by rendering archaeological data into a 3D reconstruction	**The Wikipedia entry aimed to promote public responsibility:** 'Most important for me is that they are producing something which the public can then see and even edit. At some point, if they end up doing another Wikipedia edit later on, that's also a skill, right?' (Teacher interview)

of various concepts, tools, digital literacy skills, and theories before they could *use* their epistemic agency.

The students largely stated that the **flipped structure of the course** supported their active learning. One student (*critical incident interview*) compared the assessment design with 'usual' university courses in which assessment is mostly based on exams and essays, noting that the teacher's overall focus on active learning had largely supported their learning during the course. As another student (*critical incident interview*) phrased it, the course provided an experience of experiential learning:

> The 3D model building experience is all about having an experience of the course. That brings us more than just knowledge from books - some experience in your life.

The **digital technologies** that were used in the course, such as the SketchUp software for 3D modelling, were described by most students as promoting their active learning. The students described gaining digital literacies while learning to use these technologies. This changed the students' perceptions of themselves, as many of them described being scared of the required digital skills in the course at first and then realised it was possible to learn these skills with adequate support. For example, one student (*post-course interview*) referred to themself as 'a dinosaur with technology', yet they still mastered the required digital literacies for the **3D model task**. The authenticity of these technologies felt meaningful for many students:

> We students could actually learn by using new technologies. (…) So, the benefit of learning through VR is that it prepares us for the future of learning. (*critical incident interview*)

The assessment design strongly promoted discussion and collaboration between students. Many students described the **online Perusall conversations** as something that shifted their orientation to reading materials in the course:

> When we were commenting on the readings, we were able to look into what other people have an opinion about. And then we would have counterarguments. We would ask each other questions, and then [the instructor] might have his own opinion. (*critical incident interview*)

The **3D model group task** was described as promoting an active stance towards learning. This task ensured that every time students learned new archaeological knowledge, they could use it *in practice*. Throughout the task, the students communicated by using authentic technologies, such as social media. Many students stated that **the reflective journal** seemed redundant initially but then started feeling more authentic as the course progressed.

The **online tests and quizzes** were mentioned as a way to revise and recall knowledge. Our analysis reminds us that tests have an epistemic function of validating one's skills and knowledge. Indeed, the students seemed to understand this function in a rather sophisticated way. The quizzes were described as helping to organise one's thinking at various checkpoints, or, as one student put it, they provided 'a whole picture about the structure of the course' (*critical incident interview*). The following comment illustrates how the quizzes enabled many students to take an active orientation to knowledge:

> Evaluating all of the knowledge gained over the four units of the topic made me think carefully and critically about the implications of archaeology as an academic discipline and why it has relevance and is worthwhile to learn. (*open-ended survey*)

Sense of being a user of knowledge

The second positioning denotes students as active users of knowledge. This sense of agency was provoked by the **3D model task** that asked students to find, evaluate and apply knowledge. First, the students had to learn how to find knowledge. This process was scaffolded with the **reflective journal** that prompted students to provide an annotated bibliography: 'It helped me understand how to evaluate the importance of my sources and refine my research methods'. (*reflective journal*) Learning how to use databases and library services could then be seen as important stepping stones for epistemic agency.

The students learned how to evaluate data. As archaeology often deals with old, written documents (e.g. excavation reports from the early twentieth century CE) as the primary data source, one of the course's main objectives was to teach students how to recognise and critically assess archaeological evidence. The students dealt with missing and insufficient data. The following excerpt highlights the conflicts that occurred:

> My site, the ziggurat [a temple tower], in the report the archaeologist explicitly said that he could not give an exact measurement, nor an estimation of the ziggurat. It could have been a technological limitation from the 19th century that the excavation team couldn't climb up to the summit. Nevertheless, the archaeologist did not delve further into this issue, but rather went on studying the ziggurat's water drainage system. This makes me think that leaving out part of the foundational information is acceptable as long as it doesn't stop us from finding other information that is more important about the subject we're studying. (*reflective journal*)

Juggling between objective and subjective forms of interpretation was seen in how the students described their **3D model group work**. One student opined: 'I have learned that using modern standards to justify ancient societies is not very objective' (*reflective journal*). Other students explained how they had to interpret data to renegotiate their own relationship with archaeological knowledge:

> As a person living in the present day, I hold subjective concepts when viewing archaeological evidence unconsciously. This notion came across when I had discussed with my classmates the bodies found in burial sites of the elite class. Since I noticed I may have subjective thoughts on the tangible evidence, I constantly remind myself not to interpret with a single perspective but with views from different stakeholders of the period. (*reflective journal*)

While working with the 3D model, the students integrated multimodal datasets, such as textual data, images, and videos. Importantly, the students constructed their 3D model by using 2D data. Students' experiences of dealing with data projections emphasised their active orientation to knowledge. The following journal excerpt illustrates the students' agency while converting 2D data into a 3D model:

> I am challenged to convert this 2D or textual evidence into a 3D plan. (…) The missing/unexcavated outer wall in the west and south makes it hard to narrow down its shape (it could be a triangle, trapezium or even irregular). (…) At first glance, I thought it was triangle-shaped (given that the known angle is 50°), but the remaining south buttress could not possibly cover room 61. With the addition of three rooms to the west of room 61 and considering that the fortified gate should be at the centre, the shape of the PCB [Plano-Convex Building] is likely to be a right trapezoid. (*reflective journal*)

The **virtual VR tours** at the other sites were a key experience for students in operating between the 2D and 3D worlds. The students could immerse themselves in the data using the XR technology to be inside it. This was an authentic experience of giving a tour of the site during the times of COVID-19 when travelling to another country for study purposes was impossible. Rather than just watching a video of a site, the students were able to move in with the VR glasses. One student explained that these 'virtual surroundings' provided a 'stimulation for memory' that enhanced their spatial thinking about the site: 'It's different from reading textbooks or listening to the recording or facing your screen – you can actually move around'. (*critical incident interview*)

Students described interdisciplinarity as an important factor to enhance their sense of epistemic agency. The course participants needed to integrate data and theories from disciplines such as geography, anthropology and architecture. One student elaborated on how the interdisciplinary ethos of the course pushed them to reorient themselves in relation to knowledge:

> I felt like I was a scientist, architect, historian, and archaeologist throughout the course. At first, I was scared about how I could contribute to discussions with my minimum historical knowledge. (…) I gradually realised I was learning not alone but with my classmates. People with historical backgrounds can help answer questions related to history, and likewise, I can also integrate my science background into discussions. It makes me appreciate how interdisciplinary archaeology is. (…) I usually learn passively and avoid asking questions to the greatest. Although I can confidently say that I can recall facts and understand concepts, I am weak at producing new knowledge. (…) These activities helped me realise that discussing with somebody is essential for learning and knowledge construction. (*reflective journal*)

Finally, students wielded their epistemic agency by making compromises about data. Such compromises are at the heart of knowledge work. Making compromises was not always a pleasant process. The students had to accept that their models would not be perfect reconstructions due to the limitations of the data and resources. One student reflected on how archaeological knowledge requires human creativity and interpretation, so compromises are inevitable:

> When I was writing the Wikipedia entry, which has to be based on actual findings of the site, I noticed that many parameters, like the height of the structures (which are not recorded in any sources) cannot be presented as I have done in the 3D reconstruction. It thus makes it more difficult for readers to try to visualise an image of the site. When academic sources present information as factual, we need to be cautious because some may consist of the author's hypotheses. (*reflective journal*)

Sense of contributing to society

While all the elements of the authentic assessment design promoted students' sense of epistemic agency, the 3D model group work and the accompanying Wikipedia article (the knowledge object) were connected to a *sense of contributing to society*. The students did not only produce the knowledge object for their teacher's evaluation, nor for the purposes of one university course. Instead, the knowledge object provided a real contribution to archaeological knowledge. This sense of epistemic agency reminds us of McArthur's (2023) idea about authentic assessment that promotes students' orientation to society. We extend McArthur's work by noting that it was the public aspect of the knowledge object that enabled students' epistemic agency to flourish. The students

often mentioned that the public contribution to archaeological knowledge was personally meaningful for them. For example, one student explained how such public participation enabled them to reposition themselves as a 'promoter':

> Through making the 3D reconstruction of my site, I have the chance not only to learn about archaeology but also to participate in archaeology. Learning through archaeology can also be viewed as a participation of public archaeology. Moreover, publishing a Wikipedia page provided a platform for me to publish screenshots of my 3D model, giving me a valuable opportunity to let the public know more about ancient Mesopotamian religious architecture. 3D modelling allows me to be a learner and promoter of archaeology at the same time. I hope I can let the public know more about ancient civilisations through 3D modelling in the future. (*reflective journal*)

Most students described a sense of meaningfulness, as their course assignments were not only produced for the eyes of their teacher. As one student put it, there was a 'sense of responsibility' (*critical incident interview*). Many compared the task with their previous examples of the test-driven assessment culture of Hong Kong: 'Usually at university, we do the assignments for teachers. But this time we really devote ourselves to the public'. (*critical incident interview*)

While constructing the knowledge object, the students necessarily thought about the perspective of their potential readers. Many navigated the complexities of writing for the public. One student explained that their group needed to avoid 'technical terms' and keep the text in an understandable format (*critical incident interview*). Another student commented on how they needed to carefully decide what information to include in the publication:

> What did the palace look like? What was its orientation? What was its geography? Who was the excavator? I thought about the sorts of things that might be important for the viewer. (…) I generated this third-person perspective, like, what might the other person want to know? Also that sense of responsibility that you have to present information for the public to view. I didn't really take it as some sort of assignment that I had to do for my course. I just took it as a cool activity. I told all of my friends! (*critical incident interview*)

The students largely portrayed the knowledge object construction as a transformative process. We have referred to transformation in two terms. First, as the 3D model task contributed to archaeological knowledge, it transformed the world with its modest contribution. Second, it transformed the *students* by providing an experience of a transformational relationship with knowledge (Ashwin 2014, 2022). This was exemplified by a student who explained that the 3D model was 'alive' unlike many other assessment tasks, which they connected with personal 'transformation' – a realisation that one can use their new skills and knowledge while 'speaking to the public':

> The Wikipedia entry makes us realise that we can really speak to the public with what we learned from this class. It's a way of transformation because that's a really active way of presenting what you've absorbed into some texts. (…) It's really meaningful because undergraduate students don't usually have a chance to reach out to the public. It pushes us to be a bit more ambitious and more aware that what we've done in this class eventually needs to serve the public. (…) I think the final product is good because it's a way to present what we've learned to the public. Someone else might read it someday. And that makes it alive in a way. Because for other tasks, once you hand in that homework, they are just that. But for the Wikipedia entry, someone else might continue the work that you once did. (*critical incident interview*)

Simultaneously, the students recognised many potential threats and downsides to public knowledge contribution. We see these critical voices as important articulations of one's sense of epistemic agency since public contributions to knowledge are not 'neutral'. One student pondered whether the important task of engaging the public through archaeological reconstructions might lead to potentially harmful use of such knowledge:

> Most archaeological reconstructions are ravishing in appearance, which are able to attract the public's attention from first sight. From the perspective of increasing public awareness of archaeology, elaborated archaeological reconstructions are preferred over the accuracy of the excavation data. The distortion and misstatement of excavation data are unavoidable for various purposes, from educational, economic, and sometimes political purposes. (*reflective journal*)

Many students highlighted their positioning as an epistemic agent by contemplating the potential uses and misuses of their knowledge object. One student elaborated on the 'double-edged sword' of open-access publishing:

> Incorporating my findings into a Wikipedia Entry validates the information I have decided to publish. I had the power to write on a platform which people commonly believe to be a source of objective truth. This experience and task had felt like a double-edged sword where half of me appreciated and witnessed the hard work my fellow classmates and I had put into these archaeological entries online and providing open access to such data. However, the other half sees this system as being potentially flawed and fragile, and it can be easily taken advantage of. This once again gave me the affirmation to fact check my sources and the significance of legitimate citations. (*reflective journal*)

Discussion

Our study has examined authentic assessment from the viewpoint of epistemic agency. We have conducted a case study to examine an innovative, digitally-mediated authentic assessment design RQ1) provides affordances for students' epistemic agency and RQ2) how students use these affordances. Overall, our study has discussed digitally-mediated authentic assessment as a powerful way of nurturing students transformational relation with knowledge.

Our analysis of the course syllabus, as well as the teacher interview, allowed us to unpack the affordances that digitally-mediated authentic assessment provided for epistemic agency (RQ1). The authentic assessment design contained a coherent structure whose various elements supported epistemic agency differently (Table 2). Our analysis showed that all four purposes for designing the digital into authentic assessment played their role in providing affordances for epistemic agency to occur. For example, the quizzes and the final exam ('digital assessment for better learning') provided affordances for promoting student agency – not hindering it, as some studies have implied (e.g. Nieminen and Lahdenperä 2021).

Our affordance analysis brought together the separate fields of authentic assessment and epistemic agency. Hopefully, our findings in Table 2 may inspire readers from other national and disciplinary higher education contexts beyond ours. The affordance analysis highlights how various forms of assessment technology can be used to promote students' transformative relationship with knowledge (as phrased by Ashwin 2014, 2022). To provide an example, we point to how VR technologies can be harnessed

for this purpose. While the body of literature on educational VR technologies is vast (e.g. Suh and Prophet 2018), it has largely focused on providing learning experiences that bear resemblance to realistic situations (e.g. Radianti et al. 2020) rather than on centring the ideas of knowledge and knowing. This idea establishes a novel way of reframing these educational technologies from the viewpoints of knowledge production and social good.

We have shown how the affordances for epistemic agency were realised in students' sense of agency (RQ2). Three different forms of the sense of epistemic agency were uncovered. These denote three ways in which students related themselves to knowledge. The first one – the 'sense of being an active learner' – has been discussed widely in authentic assessment literature that often portrays students as 'active' and 'cognitively challenged' (Gulikers, Bastiaens, and Kirschner 2004; Reynolds and Kearns 2017; Villarroel et al. 2018).

Our analysis showed how students also positioned themselves as *active, agentic users of knowledge*. This positioning to knowledge was particularly seen in the 3D modelling task in which students evaluated and transformed multimodal data. The students actively negotiated the knowledge structures of the widely interdisciplinary and multi-paradigmatic field of archaeology. On these occasions, epistemic agency manifested as a deep engagement with academic knowledge (Nieminen and Ketonen 2023). This way, students were positioned as epistemic agents as they became aware of the knowledge structures and knowledge production processes in their own field of study. Here, authentic digital technologies enabled this positioning to occur.

Finally, the students positioned themselves as *epistemic agents who used knowledge to contribute to society*. This happened particularly through the affordances provided by the Wikipedia task that asked students to contribute to the social good of higher education by preserving cultural heritage in its digital form. Here, we emphasise the role of meaningful, authentic and digitally-mediated *knowledge objects* for developing students' epistemic agency in assessment. While it has been suggested that authentic assessment could critically ask students to renegotiate their positioning within society (McArthur 2023), our study reminds us that this is more likely to happen if students are asked to contribute to society via meaningful knowledge objects. Indeed, our study emphasises the crucial importance of nurturing epistemic agency through assessment, rather than only learning or instruction, given that it is often assessment that fails to foster students' transformational relationship with knowledge or that even hinders it (McKenna 2022; Nieminen and Lahdenperä 2021).

Theoretical contributions

Our study contributes to theory regarding both authentic assessment and epistemic agency. First, our empirical study supplements the earlier conceptual arguments about the need to connect authentic assessment with knowledge and the social good of higher education (McArthur 2023) instead of grounding this idea purely on competencies and employability skills. We go as far as to recommend that in higher education, authentic assessment has to be grounded in knowledge and knowing, given how profound these values are for this institution. At the same time, authentic assessment has to acknowledge the digital world by promoting students' transformational relationship with knowledge in digitally authentic ways. Further empirical studies are needed to test these ideas in practice. Our study has added to the empirical evidence base, building on earlier conceptual studies (Bearman, Nieminen, and Ajjawi 2023; McArthur, 2023;

Shay 2008; Vu and Dall'Alba 2014). Overall, we challenge the literature on authentic assessment to rethink the very notion of 'authenticity' beyond ideas such as realism and employability. Instead, we suggest that 'authenticity', in assessment, could refer to authentic contributions to knowledge and society.

Moreover, our study has contextualised the idea of epistemic agency in the particular context of authentic assessment. Our analysis of affordances for epistemic agency has followed the recommendations to carefully localise such theorisations rather than to draw on universal definitions (Osborne, Dunne, and Farrand 2013). This approach emphasises the role of design elements in the quest to nurture student agency. We have departed from the norm of epistemic agency literature by conceptualising it as a societal goal rather than a psychological construct, and we welcome further studies exploring the concept regarding (digital) assessment. As our study has shown, the affordance theory provides opportunities to understand how students use assessment design elements as they develop their epistemic agency. We emphasise our contribution to understanding how meaningful knowledge objects can provide affordances for epistemic agency, as only through them can students transform the world.

Limitations and implications for research

Our study has various limitations and implications for research. First, while our case study has enabled us to link educational theory with a tangible, practical implementation (Yin 2018), this approach limits the transferability of our findings. Our study was conducted in the test-driven context of Hong Kong; perhaps in this context, the authentic assessment design felt novel and promoted more positive results than elsewhere. Future studies could examine epistemic agency and authentic assessment in other contexts with differing assessment cultures, norms and policies. Archaeology provided an intriguing context for us due to its multi-paradigmatic nature, but future studies on assessment and epistemic agency should be conducted in other disciplinary contexts, too, to understand how epistemic agency develops amidst various differing knowledge structures. Moreover, future studies could focus on alternative research designs.

Our study has solely focused on students' sense of agency rather than on agency itself (Nieminen and Hilppö 2020). Studying agency directly could be an intriguing topic for future studies. How exactly is epistemic agency enacted? What happens with the knowledge that students produce? We particularly welcome longitudinal and ethnographic approaches that would examine the development of epistemic agency *in situ* and over time. We must also understand how students wield their epistemic agency in contexts beyond higher education. Our study only focused on the imminent course context, but the question remains how the students' sense of epistemic agency developed after the course. Our critical incident interviews were only able to capture limited aspects of this idea. We also call for multimodal, digitally-mediated methods for understanding epistemic agency in authentic assessment.

Implications for practice

Our main practical implication is to propose knowledge as a central feature for future work on authentic assessment. We hope our contextual case study inspires practitioners in other cultural and disciplinary settings on how this could be done in practice.

Perhaps our most notable implication concerns the central role of meaningful knowledge objects for epistemic agency. In our study, the knowledge object was based on a real, public contribution to knowledge. This public element was fundamental for students' sense of contributing to society in the authentic assessment task. It remains a crucial question for future work to consider how such knowledge objects could be produced in authentic assessment in other disciplinary contexts. Typically, such experiences have been restricted to dissertations, capstone projects and placement experiences, yet we see it important that authentic assessment provides affordances for epistemic agency in more traditional course contexts, too. If knowledge objects are only produced for one's teacher, the sense of contributing to knowledge may not be fostered.

However, it is not always feasible to ask students produce a knowledge object with a tangible societal contribution – even a minor one. In these cases, we encourage practitioners to discuss the knowledge structures in their discipline openly with their students. This may make it explicit how knowledge should be used in authentic assessment in disciplines such as natural sciences, creative arts and social sciences. Our study has shown that authentic assessment provides affordances for increasing students' awareness of the knowledge production processes in their own field of study. In our case, the teacher spent considerable time discussing the knowledge production processes of archaeology in his lectures.

Conclusion

Our study has explored how authentic assessment could provide affordances for students' epistemic agency and how such affordances were realised in practice in an archaeology course. We have reclaimed the notion of 'authenticity' by exploring what might be achieved when this powerful idea centres students' authentic contributions to knowledge and society. Our case study was conducted in a single university course, yet the authentic assessment design quite successfully fostered the students' sense of epistemic agency. For us, this is a hopeful idea of the power of assessment design in individual courses. We call for further studies on authentic assessment to unpack how higher education could better prepare students to evaluate, use and transform knowledge in the increasingly digital societies.

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