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Digital Empowerment and School–Enterprise Co-Education in Red Culture Education: A Case Study of Virtual Heritage Practice in a Chinese Higher Vocational College

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Abstract: Revolutionary heritage sites, known in China as red culture resources, are widely used for civic education, but their educational reach is limited by distance, opening times and the conditions of the sites themselves. This article presents a qualitative case study of how the animation production technology programme group at Xi'an Vocational and Technical College, working with Xi'an Xinkun Information Technology Co., Ltd. and provincial cultural bodies, used digital technologies to extend access to these resources while integrating them into professional training. Drawing on documentary analysis of project records and institutional reports, interpreted through research on immersive learning and digital heritage, the study identifies three components. The first is a digital matrix comprising an online education platform for revolutionary relics, a cloud exhibition presenting 100 revolutionary sites through virtual-reality panoramas, and an on-campus virtual-reality experience hall. The second is a production system in which students and enterprise engineers create heritage content and new communication carriers, such as a themed public transport card. The third is a two-way arrangement in which students learn professional skills through heritage projects while the outputs serve the public. The programme reports more than 10 million online readers, more than 6,000 offline visitors and coverage by over 40 media outlets, although these figures come from its own records and measure reach rather than learning. The analysis suggests that the main contribution of the case lies in combining heritage access with authentic production work, and that evidence on learning outcomes is needed.

Keywords: Red culture, digital heritage, virtual reality, school–enterprise cooperation, vocational education, case study

1. Introduction

Heritage sites are among the most widely used resources for civic and historical education, yet their educational reach is constrained by geography. Visits require travel, time and supervision, sites may be fragile or remote, and teachers cannot easily return to a site when a later lesson would benefit from it. In China, sites associated with the revolutionary period, together with their relics and narratives, are referred to as red culture resources and are used extensively in schools and universities for civic education.

Shaanxi Province is particularly rich in such resources, including sites in Yan'an and the Eighth Route Army Xi'an Office. According to the programme team at Xi'an Vocational and Technical College, three problems limited their educational use: students and teachers could not visit sites whenever needed; the digital presentation of the resources was underdeveloped and relied on a narrow range of communication methods; and heritage education was disconnected from students' professional training, so that cultural learning and skill development proceeded separately.

National policy encourages solutions to all three. The 14th Five-Year Plan for cultural development calls for the digital transformation of cultural resources and for new forms of cultural communication (General Office of the CPC Central Committee & General Office of the State Council, 2022), and national guidelines on curriculum ask professional courses to integrate values education, including cultural literacy and national identity, rather than leaving it to separate courses (Ministry of Education of the People's Republic of China, 2020). Throsby's (2001) distinction between the economic and cultural value of cultural goods is a reminder that digitising heritage involves interpretive choices, not only technical ones.

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Digital technologies offer a way of extending access to heritage. A survey of augmented, virtual and mixed reality in cultural heritage found these technologies used for education, exhibition enhancement, exploration, reconstruction and virtual museums, and noted that they make heritage accessible especially when physical access is constrained (Bekele et al., 2018). Research on museum learning, however, emphasises that meaning is constructed through the interaction of personal, sociocultural and physical contexts, so that access alone does not guarantee learning (Falk & Dierking, 2013).

Two bodies of research are therefore relevant: work on whether, and under what conditions, immersive technologies support learning, and work on how learners develop competence by producing authentic artefacts. Both are reviewed in Section 2.

Few studies examine cases in which vocational students themselves produce virtual heritage for public use, combining the two lines of research. Chinese accounts of red culture education in vocational colleges tend to report initiatives and their reach without stating how evidence was gathered or linking practice to research on immersive learning. This article addresses that gap through a case study of a programme at Xi'an Vocational and Technical College. It asks: (1) How did the programme use digital technologies to extend access to revolutionary heritage? (2) How were heritage projects integrated into students' professional training? (3) What does the available evidence show, and what does it not show?

2. Literature Review

2.1 Access, Context and Meaning in Heritage Learning

Digital heritage research distinguishes between several purposes for immersive technologies: education, the enhancement of exhibitions, exploration of sites, reconstruction of what no longer exists, and virtual museums (Bekele et al., 2018). These purposes call for different technologies. Augmented reality overlays information on a physical site, mixed reality blends physical and virtual objects, and virtual reality replaces the physical environment entirely, which makes it the obvious choice when the site cannot be visited. The same survey stresses that technology choice should follow the intended use rather than the reverse.

Research on museum learning offers a framework for judging whether access leads to learning. Falk and Dierking (2013) describe the visitor experience as the product of personal, sociocultural and physical contexts: what visitors bring with them, whom they visit with and how they interact, and the design of the space and objects they encounter. Applied to virtual heritage, the framework suggests that a panoramic tour viewed alone on a phone and the same tour discussed in a guided class are different learning experiences, even if the content is identical. Usage statistics alone cannot distinguish between them.

2.2 Immersion, Presence and Instructional Design

The Cognitive Affective Model of Immersive Learning identifies presence, the sense of being in the virtual place, and agency, the sense of being able to act there, as the two general affordances of immersive environments (Makransky & Petersen, 2021). These affordances can raise interest, motivation, self-efficacy and embodiment, but they can also increase cognitive load, so that a highly immersive experience may engage learners while reducing what they retain. The model therefore treats instructional design, not immersion as such, as the main determinant of learning.

Empirical reviews are consistent with this view. Merchant et al. (2014) found that virtual reality-based instruction improved learning outcomes on average, with effects that varied by design features such as feedback and the type of environment. Jensen and Konradsen (2018) found that head-mounted displays helped with spatial and visual knowledge and observational skills but offered no advantage elsewhere, partly because of cybersickness and distraction. Radianti et al. (2020) found that most educational virtual reality applications were developed without explicit learning theory and evaluated mainly for usability. For heritage education, these findings suggest that spatial understanding of a site is a realistic goal, whereas historical understanding requires additional instructional support.

2.3 Production as Learning

A different body of research concerns learning through the production of artefacts. Experiential learning theory describes a cycle in which concrete experience is followed by reflective observation, abstract conceptualisation and active experimentation (Kolb, 2015). Situated learning theory describes how newcomers become competent by participating in the authentic practice of a community, initially in peripheral roles (Lave & Wenger, 1991). Both perspectives imply that students who model a heritage site, write its interpretation and design its interaction are learning in ways that differ from those of the people who later view the result.

Project-based learning research identifies the conditions under which such production supports learning. A review found that effective implementation depended on modern digital technology, high-quality group processes, teachers' ability to scaffold students' learning, a balance between direct instruction and inquiry, and assessment aligned with the project (Kokotsaki et al., 2016). The same review noted that most studies used quasi-experimental designs without

random allocation, so causal claims remain uncertain. These conditions provide a framework for examining how heritage production projects are organised in the present case.

3. Case Study Method

3.1 Research Design

The study adopted a qualitative, single-case design that is descriptive and interpretive in purpose (Yin, 2018). The unit of analysis is the programme group's digital red culture work, comprising its access platforms, its production system and the arrangements linking production to teaching and public service. The case is bounded by the period from the establishment of the enterprise partnership in 2010 to the most recent recognition reported in 2023. The aim is to describe how digital heritage access and student production are organised, and to interpret them through research on immersive learning and digital heritage; the design makes no causal claims about the reach and recognition reported in Section 4.4.

The evidence is documentary (Bowen, 2009), consisting of project records, platform documentation and usage statistics, complemented by the authors' practitioner knowledge as staff of the programme group.

3.2 Case and Context

The case is the digital red culture education work of the animation production technology programme group at Xi'an Vocational and Technical College, which the college describes as based on a state-level digital productive training base. The main enterprise partner is Xi'an Xinkun Information Technology Co., Ltd., which, according to the college, has been located on campus since 2010. Other partners include the Shaanxi Provincial Cultural Relics Bureau, the Eighth Route Army Xi'an Office Memorial Hall and a public transport company.

3.3 Evidence Base

Four types of document were used, each linked to particular findings (Table 1): documentation of the online platform, cloud exhibition and experience hall; records of the production platform and of projects such as the themed transport card; curriculum and project records showing how students took part; and usage statistics, award certificates and media reports.

Table 1 - Evidence Base Mapped to the Findings

Finding area	Main evidence	What the evidence can show	What it cannot show
Digital matrix (4.1)	Platform, exhibition and experience hall documentation	Technologies used, content covered and modes of access	How users engage with or learn from the content
Production system (4.2)	Production platform records; transport card and other project records	Production capacity and outputs created	Quality of instructional design
Training and service (4.3)	Curriculum and project records; activity records	How projects connect with courses and public use	Individual students' learning
Reported outcomes (4.4)	Usage statistics, awards, media reports	Reach and recognition	Learning outcomes for students or users

3.4 Analytic Framework and Procedure

The analysis proceeded in three steps. First, documents were organised deductively under the programme's three components: access platforms, production system, and the link between training and public service. Second, statements within each component were coded thematically for technologies, users, activities and student roles (Braun & Clarke, 2006). Third, the coded material was interpreted through the contextual model of museum learning (Falk & Dierking, 2013), the cognitive affective model of immersive learning (Makransky & Petersen, 2021) and experiential and situated accounts of learning through production (Kolb, 2015; Lave & Wenger, 1991). A feature was reported only when it appeared in at least two documents, and measures of reach were kept distinct from evidence of learning.

3.5 Positionality and Limitations of the Evidence

The authors work at the college whose programme is described. Most evidence was produced by the programme or its partners, and much of it measures reach (visits, views, reports) rather than learning. Students' and users' perspectives were not collected independently, and there is no comparison group. The findings therefore describe how the programme is designed and reported, not its effects on learning.

4. Findings

4.1 A Digital Matrix for Extending Access

The first component is a digital matrix of three linked platforms, summarised in Fig. 1. First, the college and its enterprise partner used 5G, virtual reality and video-cloud technologies to build an online education platform for Shaanxi revolutionary cultural relics, which integrates digitised resources from across the province and can be accessed through computers and mobile phones.

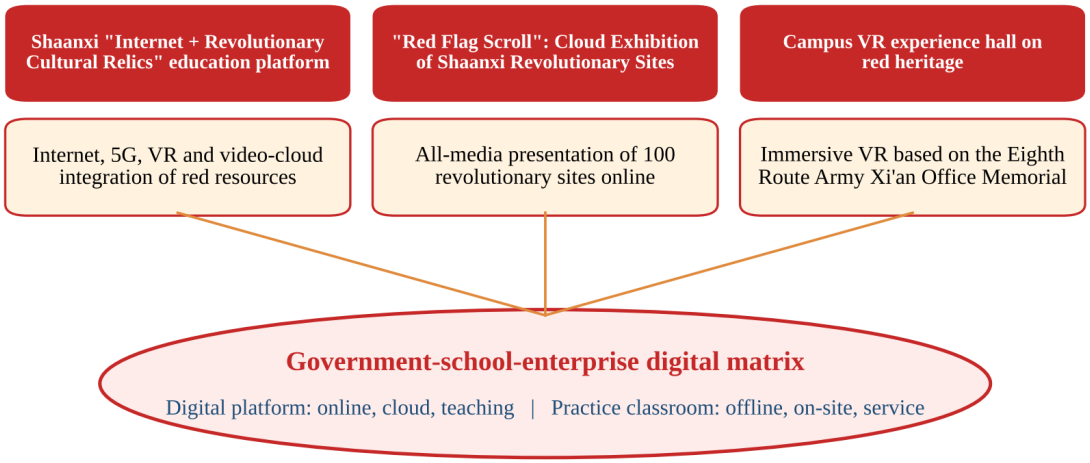


Fig. 1 - The Government–School–Enterprise Digital Matrix for Red Culture Resources

Second, the partners produced a cloud exhibition titled “Red Flag Scroll: Shaanxi Revolutionary Sites on the Cloud”. One hundred sites of historical importance, including Baota Mountain in Yan’an and the Zhaojin Memorial Hall, were presented through virtual-reality panoramic streaming and made available through WeChat and a mobile application. Users scan a QR code to explore sites through 720-degree panoramas and three-dimensional navigation. The programme reports more than 10 million online readers.

Third, the college built an on-campus virtual-reality experience hall based on the Eighth Route Army Xi’an Office Memorial Hall. Visitors navigate a virtual version of the site, examine relics and listen to explanations. The online resources and the offline hall are intended to complement each other, supporting learning in different settings and for different purposes. The hall is open to all teachers and students and is used in thematic activities, science and technology events and the national Vocational Education Activity Week.

4.2 A Production System for Heritage Content

The second component is a production system built on the programme’s long-standing partnership with the enterprise. Drawing on an animation workshop, a virtual-reality training room and a digital creative simulation room, the college reports a production platform that can support about 100 users simultaneously in modelling, rendering, compositing, data analysis and online promotion of film, television and animation content.

This system has produced communication carriers beyond the platforms themselves. The most visible is a public transport card themed on revolutionary relics. It uses an intellectual property character, “I am Little Eighth Route”, developed for the Eighth Route Army Xi’an Office Memorial Hall, and users can scan a QR code on the card to watch short videos about relics. The programme also uses three-dimensional panoramic navigation to replace one-way presentation with interactive experience. Table 2 summarises the components.

Table 2 - Components of the Digital Red Culture Education Programme

Component	Technology	Users and purpose	Student role
Online relics education platform	5G, VR, video cloud	Province-wide online access to digitised resources	Content production and maintenance
Cloud exhibition of 100 sites	VR panoramic streaming; WeChat and app	Public and students; remote exploration	Panoramic capture, modelling, cloud development

Component	Technology	Users and purpose	Student role
Campus VR experience hall	Immersive VR and interaction	Teachers, students and visitors; on-site immersion	Scene modelling and interaction design
Themed transport card	IP design; QR-linked video	Commuters; everyday contact with heritage	IP and card design; video production

4.3 Two-Way Empowerment of Training and Public Service

The third component links professional training and public service. Professional teachers, enterprise engineers and students work together on heritage projects, connecting teachers' studios with the enterprise technician workstation and real work projects, such as the transport card design and cloud development, with core professional courses. In these projects students practise modelling, rendering and compositing while engaging with the historical material, an arrangement the programme summarises as learning by doing and learning by communicating.

The resources are also used in the college's wider education activities, including thematic events and open days. The experience hall is open to all teachers and students, and during the campus closure of 2022 the online resources allowed members of the college to continue visiting sites remotely. The cloud exhibition has also been used in government service halls, enterprises and schools. In this way, students act both as learners and as producers and communicators of heritage content.

According to the programme, these projects are embedded across the curriculum in a three-level progression from classroom to teachers' studio to the enterprise workstation. Students first learn techniques in courses, then apply them in studio projects supervised by teachers, and finally contribute to commissioned work alongside enterprise engineers. Real projects named in the documents include the transport card design, cloud development for the exhibition and the construction of a virtual-reality resource library. Because teachers, engineers and students work on the same project, the programme argues that technical standards, workplace norms and the historical content of the work are learned together rather than in separate courses.

4.4 Reported Outcomes

The programme reports the outcomes summarised in Table 3. They come from its own records and partner reports, and most measure reach or recognition rather than learning.

Table 3 - Outcomes Reported by the Programme

Area	Reported outcome
Reach	More than 10 million online readers of the cloud exhibition; more than 6,000 offline visitors to the VR experience hall; about 30,000 online learners
Recognition	Coverage by more than 40 media outlets, including Xuexi Qiangguo ("Learning Power"), People's Daily and Xinhua News Agency; Xi'an Lifelong Learning Brand Project (2023); Best Creative Award in the interactive category of the third Shaanxi History and Culture Animation and Game Competition for a VR exhibition of Xi'an Party history relics
Institutional	Contribution to a provincial model Party branch; visits by other institutions, including Shenzhen Polytechnic in 2023

Note. Source: programme records and partner reports. The documents do not specify how readers and online learners were counted. A visit by a provincial leader reported in the original manuscript has been omitted because it is an endorsement rather than evidence of outcomes.

5. Discussion

5.1 Extending Access to Heritage

The digital matrix addresses the first problem identified by the programme: limited access to sites. The cloud exhibition and online platform make distant sites available at any time, and the reported reach is large. This is consistent with the use of virtual and mixed reality to make heritage accessible where physical access is constrained (Bekele et al., 2018). Reach is not the same as learning, however. Research on museum learning emphasises that meaning depends on visitors' personal and social contexts (Falk & Dierking, 2013), and the available figures do not show how long users engaged, what they understood or how the resources were used in lessons.

5.2 Designing Immersive Experiences for Learning

The experience hall and panoramic exhibitions are immersive in different degrees. The literature suggests that immersion supports learning when experiences are designed to foster presence and agency and to manage cognitive load (Makransky

& Petersen, 2021), and that advantages are clearest for spatial and visual knowledge (Jensen & Konradsen, 2018). Heritage sites are strongly spatial, which suggests a good fit, but the programme documents describe technologies rather than instructional design. The finding of a systematic review that educational virtual reality is often evaluated for usability rather than learning (Radianti et al., 2020) applies here as well.

A practical implication is that the platforms could be paired with simple learning designs. A visit to the virtual site could begin with a question that requires spatial exploration, include prompts that direct attention to particular relics, and end with a short discussion or written reflection. Such designs would draw on the strengths that reviews identify for immersive media, namely spatial and visual understanding (Jensen & Konradsen, 2018), while adding the reflection that experiential learning theory treats as essential (Kolb, 2015). They would also make it possible to collect evidence of learning rather than of access alone.

5.3 Students as Producers of Heritage Content

The most distinctive feature of the case is that vocational students produce the heritage content. Their participation in modelling sites, designing the transport card and developing cloud exhibitions gives them authentic projects with real users, consistent with experiential and situated accounts of learning (Kolb, 2015; Lave & Wenger, 1991). Working with historical material also requires interpretive decisions about what to show and how, which may deepen students' engagement with the content more than passive viewing would (Dewey, 1938). This combination of professional training and heritage education is the programme's response to the policy aim of integrating values education into professional courses (Ministry of Education of the People's Republic of China, 2020), but its effects on students' skills and understanding were not assessed.

The programme describes the relationship with its enterprise partner as symbiotic: the enterprise gains creative capacity and access to talent, the college gains current technology and teaching resources, and students' work is exposed to public use and scrutiny. Measured against the conditions that project-based learning research associates with effective practice (Kokotsaki et al., 2016), the arrangement offers modern digital technology and authentic tasks in abundance. Less is known about the other conditions: how teachers scaffold students' contributions to commissioned work, how group processes are managed when deadlines are set by external clients, and how assessment recognises individual learning within collective products. Documenting these aspects would strengthen the case that the projects are educational and not only productive.

5.4 Interpretation and Responsibility in Representing Heritage

Producing heritage content for public use carries responsibilities that ordinary student projects do not. Choices about which sites to digitise, which objects to foreground and how to narrate events shape how users understand the past. Throsby's (2001) account of cultural value, which includes historical and symbolic dimensions, implies that these choices should be made deliberately and with expert input. The programme documents describe close cooperation with the Provincial Cultural Relics Bureau and the memorial hall, which suggests that interpretive decisions were reviewed by heritage professionals. Documenting how students participate in these decisions, and how disagreements are resolved, would show whether the projects develop students' interpretive judgement as well as their technical skills.

5.5 Implications for Other Colleges

For other colleges, the case suggests that heritage resources can provide authentic projects for media and design students, that long-term partnerships with enterprises located on campus can sustain production capacity, and that public-facing outputs can motivate students and extend the value of their work beyond the classroom. Colleges adopting similar approaches would benefit from planning evaluation from the start, including measures of engagement and learning for both student producers and end users, as the immersive learning literature recommends (Merchant et al., 2014; Radianti et al., 2020).

5.6 Limitations and Further Research

Four limitations qualify these findings. The evidence is documentary and produced largely by the programme; most figures measure reach rather than learning; users' and students' perspectives were not collected independently; and the authors' position may have shaped interpretation. Further research could assess what users learn from the cloud exhibition and experience hall, compare the skills of students who worked on heritage projects with those of other students, and examine how teachers integrate the resources into lessons.

6. Conclusion

This case study described how a vocational college used digital technologies to extend access to revolutionary heritage while integrating heritage projects into professional training. The programme combines an online platform, a cloud

exhibition and an experience hall with a production system in which students and enterprise engineers create heritage content for public use.

Read through research on immersive learning and digital heritage, the case's main contribution lies in combining heritage access with authentic production work. Its reported reach is large, but evidence on learning, for both the students who produce the content and the people who use it, is needed before the approach can be judged as a model for other colleges.

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Conflict of Interest

The authors are employed by Xi'an Vocational and Technical College, the institution whose programme is described in this case study. The authors declare no other conflicts of interest.

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