# A PROPOSAL FOR AN IMMERSIVE VIRTUAL REALITY COMPETENCIES FRAMEWORK FOR HISTORY TEACHERS: TOWARDS A SPECIALIZATION OF TPACK

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## Abstract

History education faces challenges engaging students due to its complexity, hindering understanding of key concepts like causality or multiperspectivity. Immersive virtual reality (iVR) is being broadly implemented in heritage institutions, and some history teachers are beginning to explore its potential to support learning. However, insufficient technological-pedagogical knowledge complicates its implementation while the competencies needed for K-12 history teachers remain unexplored. Knowledge required to effectively implement iVR in history education is presented, aiming to discuss a model covering the various areas that should be developed for successful history education through iVR.

## Introduction

Immersive technologies such as virtual reality (VR) and augmented reality (AR) are giving new opportunities in many fields, including education. VR has been found in educational contexts since the 1960s (Page, 2000), even if the term VR was coined as late as 1989 (Rheingold, 1991). In the 21st century there has been a fast development of new VR technologies where the so-called second wave of VR has brought on a wide variety of new displays and input devices that has increased the sense of immersion (Anthes et al., 2016). In AR applications, the real world can interact with the virtual, while VR applications are completely disconnected from the real world. In the fast technological development where VR has become more and more alike to the real world, two different types of VR can be identified: 1) Non-immersive VR and 2) Immersive VR (iVR).

While the first type consists of a computer-based environment that simulates contexts in the real or imagined worlds, iVR more strongly gives the user a perception of being physically present in a non-physical world. Non-immersive VR can be installed on, and run from, standard computers, while iVR applications need special devices such as head mounted displays (Freina & Ott, 2015). The combination of immersion and interaction functionalities in iVR applications make

these environments useful in education. Educational iVR applications enable learners to experience worlds and topics that could be impossible or dangerous to visit in real-world settings (Kavanagh et al., 2017; Serin, 2020). In the context of history education, impossible worlds in the past could be exemplified as a city tour around lost heritage and urbanism (Checa et. al. 2019, Villena et al., 2022).

Research studies have explored and discussed pedagogical possibilities (Häfner et al., 2018) and motivational aspects (Stepan et al., 2017). However, there are fewer studies discussing how iVR should best be used and applied in the more specific field of history education (Serrano-Ausejo & Mozelius, 2024). iVR for education requires specific competences that should relate to the specifics of the technology itself. These competences are framed within the European competencies' digital framework and the Technological Pedagogical Content Knowledge framework (see "Theoretical Framework" section below), that was proposed by Punya Mishra and Matthew Koehler (2006). Grounding on these two theoretical pillars, the authors' aim is to present and discuss a specific framework that can be used for iVR-based history education.

## Theoretical Framework

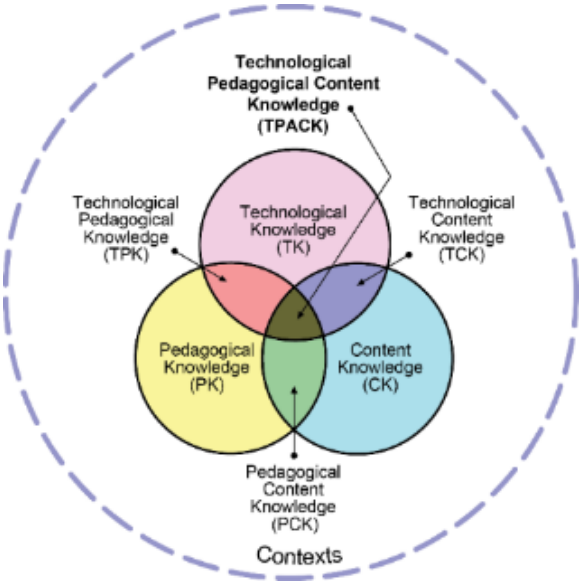
This study is grounded in the Technological pedagogical content knowledge framework (TPACK) and the European Digital Competences Framework.

### Technological Pedagogical Content Knowledge

The TPACK framework (Mishra & Koehler, 2006), delineates three domains of knowledge essential for integrating technology into teaching: pedagogical knowledge (PK), content knowledge (CK), and technological knowledge (TK). These domains encompass teachers' expertise in didactics and pedagogy (PK), subject matter (CK), and technological proficiency (TK). The interaction of these domains forms new areas of knowledge (Figure 1). Technological Content Knowledge (TCK) is the integration of technology and content knowledge, exemplified by the use of iVR applications to enhance history education. Pedagogical Content Knowledge (PCK) focuses on selecting pedagogical strategies suitable for specific content areas. Technological Pedagogical Knowledge (TPK) involves applying appropriate pedagogical approaches to support the chosen technology. In this study, it includes how history teachers might adapt their pedagogical strategies when using iVR compared to traditional text-based activities (Mishra & Koehler, 2006; Koehler & Mishra, 2008).

**Figure 1**

*The TPACK Model*




*Note*: Image from tpack.org (2012); site is currently inactive. Alternative reference available at Mishra (2018).

TPACK gives an overall understanding of the competencies that must be developed by the teacher who wants to implement technology, but it is insufficient to understand the different levels of technology involvement in teaching, from a basic to a proficient level. To complete TPACK, the following framework was employed.

## The European Digital Competences Framework

The European Commission has launched an initiative on digital competence with the intention of improving the digital skills of citizens in different areas. This initiative has been embodied in the European Digital Competences Framework (DIGCOMP) for European citizens. In 2017, in different countries such as Austria, Ireland, Spain, Norway, and Germany among others, the initiative to apply it to education was launched, and for this reason the European Commission generated a new initiative to guide teachers about the different digital competencies, the Digital Competence Framework for Teaching (DIGCOMPEDU). The Digital Competence Framework for Teachers (Redecker, 2017), categorised six areas of digital knowledge (Figure 2): professional engagement, digital content, teaching-learning process, assessment and feedback, learner empowerment, and development of learner digital competence.

**Figure 2**

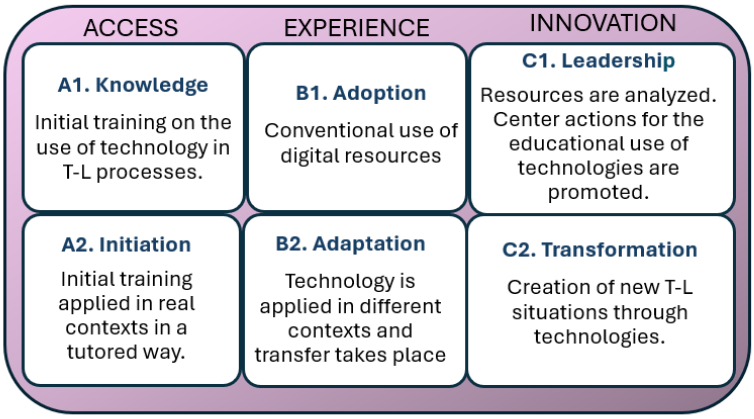
*European Framework for the Digital Competence of Educators*


*Note*: Image from Redecker (2017).

Each of these areas corresponds to the following levels of competence: A1, A2, B1, B2, C1, and C2, where level A gives basic access to technology, level B gives experience and level C refers to the capacity for teaching innovation through technology (Figure 3).

**Figure 3.**

*Teachers' Digital Competence Framework*




*Note*: Image from Spanish Ministry of Education, 2022. Translation by the authors.

## Methodology

This is a Position paper that relies on the expertise of three experts engaged in iterative discussions to establish a consensus in order to define the essential competencies framework required for history education through iVR. They fulfilled the required inclusion criteria: 1) possessing a higher education degree in history, ensuring a deep understanding of the discipline; 2) expertise in teacher education, ensuring consideration of the knowledge and competencies students need to develop in history and the requisite didactics; 3) substantial knowledge and experience in iVR for educational purposes, crucial for discussing the necessary competencies for effective history teaching via iVR; and 4) a perception of history education as a contemporary field where students are encouraged to be critical and active learners, moving away from repetition and memorization.

It's worth noting that all three experts are also authors of this study, each holding master's degrees in social sciences teaching. To extend the informants' knowledge of technology and the instructional possibilities of iVR, this Position paper draws on extensive discussions with researchers from the Centre for Innovation and Technology in Video Games and Audiovisual Communication (ÍTACA) at Burgos University and a pilot project funded by Erasmus + where four teachers were instructed according to the model. However, this Erasmus project is still a work in progress and can not offer clear results yet.

## Results

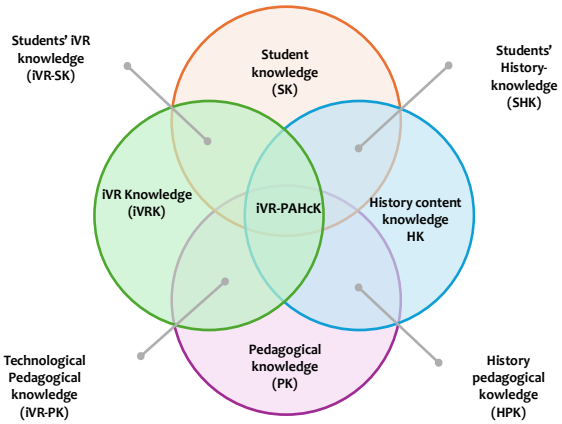
The results of this study are drawn in two different models that are described below: 1) iVR Pedagogical History Knowledge framework (iVR-PAHCK) and 2) the iVR-ladder for history teachers' education in iVR.

### iVR Pedagogical History Content Knowledge Model

The first model (Figure 4), adapted from TPACK for history education with iVR, includes four overlapping domains. In addition to the three domains of the TPACK model, a fourth domain focuses on teachers' understanding of students' technology and content knowledge. This knowledge is crucial in history education as it can influence learning outcomes (Noel Mera, 2023), communication of history, technology use, and even content adaptation based on students' backgrounds (Almerich et al., 2019, p. 61).

**Figure 4**

*iVR-PAHCK Model*

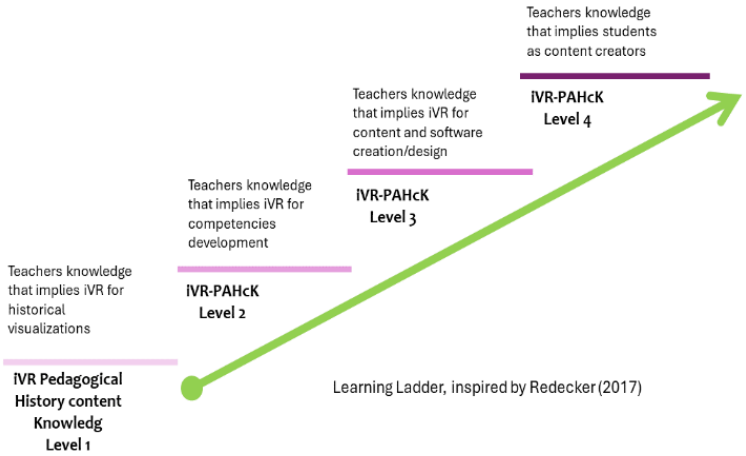



*Note*: Diagram is original work of the authors.

Illustrated in Figure 4, the iVR-PAHCK model creates four intersecting domains: 1) Students' iVR knowledge (iVR-SK); 2) students' history knowledge (SHK); 3) history pedagogical knowledge (HPK); 4) and iVR pedagogical knowledge (iVR-PK). This model proved effective to understand what knowledge is necessary for history teachers to implement iVR successfully, but it is insufficient to know the different levels of digital competence for history teaching and its implications for the learning outcomes. In order to describe the different competency levels of iVR for history education, a second model was created (Figure 5). The interaction of both models is essential, as iVR-PAHCK should be integrated into each step of the process to ensure successful implementation.

**Figure 5**

*The iVR learning ladder for history teachers' education*




*Note*: Diagram is original work of the authors.

## The iVR-ladder for History Teachers' Education

The ladder metaphor represents a constructive learning process, building new knowledge upon the previous, ensuring a solid foundation, fostering certainty and facilitating success. Implementing new methods without necessary competencies can cause stress among stakeholders. While some space for trial and error is beneficial, lack of control and understanding may lead to resistance to teaching innovation. See Figure 5 for an overview of the suggested steps.

## iVR Pedagogical History Content Knowledge, Level 1

The initial step involves integrating iVR to immerse students in historical experiences, enabling embodied interactions with historical objects and emotional engagement, thereby enhancing contextualization and understanding. Teachers must have a positive and curious attitude toward technology, and referring to Redecker's (2017) framework, teachers should acquaint themselves with the technology's functionalities and allocate resources and time to find suitable applications aligned with learning objectives. As teachers gain experience, their ability to troubleshoot technical issues is expected to improve, paralleling the growth of students' problem-solving skills in an iVR environment. Furthermore, teachers' capacity to design iVR-integrated lessons will expand with experience, progressing from standalone visualizations to interconnected activities that promote reflection and inquiry.

Crucial professional skills include research and analysis of suitable digital content and applications for history teaching and learning (Szlachta Junior, 2023, p. 42), getting familiar with existing platforms and databases. Besides, iVR content must be implemented critically and functionally, involving the design of units that start from learning goals and learning difficulties, and including ethical considerations that should consider the previous experiences of students in case emotions can be severely touched. Teachers must consider the new teaching-learning dynamics to maintain a positive educational environment, as iVR can dramatically alter the classroom setting. All in all, being aware of the changes the iVR will bring to the classroom to assure positive educational environments, being familiar with applications that are effective and appropriate for history education, plus designing proper units that work on goals and desired learning outcomes, would be the main competencies that frame this first step. The activities that involve iVR would involve visualizations, and interaction when available, while the whole unit might consider other actions such us reflection, conversations, or others.

## iVR Pedagogical History Content Knowledge, Level 2

The implementation of iVR needs the design of virtual learning ecosystems adapted to various formative stages and different areas of K-12 education, creating customized pedagogical solutions (Rubio, 2023). Besides, the challenges faced by the educational system require students to be trained in evaluating content drawbacks to ensure the experience transcends mere entertainment (Miguélez-Juan et al., 2019, p. 163). This adds extra complexity for teachers and demands greater digital competence, as students need to learn about technology's limitations and drawbacks. This level focuses on using technology to support competency development, which is heavily dependent on the national or local curriculum.

Special emphasis is placed on critical thinking and historical consciousness. These competencies are generally established in many parts of the world and require a practical understanding of the subject. While iVR might help develop competencies such as imagination, considering the emotional impact of iVR on users (Kazlauskaité, 2022), critical thinking might be compromised (Serrano-Ausejo, 2023; Serrano-Ausejo & Mozelius, 2024).

Teachers working at this level of development are expected to enhance these competencies by supporting the analysis of sources and authorship, fostering a historical imagination that extends beyond the given narrative, and connecting the present to the past and the past to the future. This approach goes beyond visualizing content and narratives, requiring more active engagement. Technologically, the teacher masters the available platforms and software, builds a supportive teachers' network to implement new pedagogical experiences that support competency development, learns how to solve technological failures, and achieves a deep understanding of the technology in use as well as students' reactions and their trust.

## iVR Pedagogical History Content Knowledge, Level 3

At this level, teachers skilled in Virtual Reality Knowledge (iVRK) and pedagogy (iVR-PK) create and develop content, needing continuous knowledge updates to adapt methodologies and proficiently utilize resources. Evidenced by Cabero-Almenara et al. (2018, p. 75) the change to active methodologies cannot occur without an assimilation and transmission of knowledge by the teacher.

The creation of iVR pedagogical materials involves a series of teaching skills that include programming, computer validation, image processing or rendering, among others (Nikou et al., 2022, p. 205), besides a critical approach that directly connects content created with pedagogical goals. The difficulty of the task is high and corresponds to a level C1-C2 of The European proposal (see Figure 3). It includes aspects such as creation but goes further by pointing out aspects as reuse, sharing,

and management of resources. Therefore, the management of the different licensing systems is another skill that the teacher must acquire, either for reuse, or for creation (García Nincehelser, 2018). As Nikou et al. (2023) suggest, the modification of resources for reuse and adaptation in different contexts should be considered in the creation process. A collaboration among teachers with the aim to transform classroom praxis by putting technological resources (Raposo-Rivas & Escola, 2016) is especially important for iVR material, due to the time and skills needed for development. Consequently, teacher collaboration will lead to distributed leadership and empowerment in the classroom facilitated by autonomy and new knowledge (Aleman-Saravia, 2023, p. 25). Overall, training on platforms or engines that enable the design, creation, transfer, and sharing of models would empower teachers to virtually shape their own vision of the virtual content they wish to use, keeping them away from other content that may not have been created for educational purposes.

## iVR Pedagogical History Content Knowledge, Level 4

The fourth level emphasizes the importance of students' prior technology knowledge (iVR-SK). Despite being digital natives, students often lack the necessary skills for critical and advanced use of technology. Also, research by Helsper and Eynon (2010) demonstrates that teachers trained in digital competencies can surpass students in learning-related competencies, enabling them to create self-regulating activities (Reginald, 2023). In an immersive environment, teachers can help students create their own historical iVR content, acting as digital historians and applying their own vision of history and previous knowledge.

The shift towards content creation is significant as the visualization and embodiment features of iVR, which were once the most considered, now share the spotlight with content creation possibilities. This creative process manifests in diverse ways, with the Cospaces platform emerging as a favorite among teachers (Gomez Muñiz, 2021a, 2021b). It's a platform where students can program their own content, whereby also acquiring basic programming skills. They can create environments and incorporate animations, sounds, stories, and text. Other examples are 360 videos, 3D modelling, and photogrammetry, which vary in complexity and skill requirements. This technology allows students to apply prior knowledge and offer their own perspectives on history after reviewing sources, moving away from predetermined narratives. This aligns with level 6 of the Redecker framework, which focuses on fostering students' digital competence, autonomy, and empowerment (Redecker, 2017). It is expected that the teacher has mastered the level 3, so she can transfer the creation and creative skills to the students, but also comprehending the diversity in iVR-SK in the group is essential to support those with lower previous technological knowledge. Besides, those students with low SHK might need some motivation to implement historical content in their creations.

## Discussion and Conclusion

A competent teacher in iVR-PAHCK is suggested to help students acquire historical competencies through iVR, facilitating a scaffolding process that considers students' individual backgrounds and aims for high digital competence. Teachers' learning is structured in four steps, each resulting in different learning outcomes. Each of the steps requires knowledge of the teacher organised in technological, content, and pedagogical knowledge under the influence of TPACK, but adds an extra domain involving knowledge regarding students' previous knowledge in the subject and in the technology.

The choice of a ladder as a metaphor for the model was due to the increase of complexity. This might suggest that history educators, at least those with low or basic knowledge in iVR, should start at level 1 and 2 (visualizations and competencies development) before they take a role as iVR designers or content creators. Also, they have to be aware of the difficulties that level 4 implies, where students might feel frustrated if they lack sufficient digital competence. However, considering the future that awaits today's students, it is convenient to help them to master digital technologies, while a modernization of the subject might also help in its survival.

Further work will test the model on a broader number of teachers, aiming for validation that has not yet been confirmed.

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