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THE MECHANISM FOR DEVELOPING HISTORICAL THINKING OF PRE-SERVICE HISTORY TEACHERS THROUGH VIRTUAL MUSEUMS: MODULAR CONTENT, PEDAGOGICAL MODEL AND ASSESSMENT CRITERIA

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Abstract
The digital transformation of education requires future history teachers not only to know historical facts but also to select, critically evaluate and didactically adapt digital sources. Although virtual museums offer rich material for this purpose, their mere availability does not guarantee the development of historical thinking. This study aimed to develop a mechanism for fostering the historical thinking of pre-service history teachers through virtual museums and to test its effectiveness experimentally. The study drew on systemic, competency-based, activity-based, context-and-source, constructive, axiological and reflective approaches; theoretical analysis and modelling were combined with a three-stage pedagogical experiment conducted in 2024–2026 at three Uzbek universities with 438 students (experimental group n = 217; control group n = 221). The didactic potential of virtual museums was specified in five priority areas: work with historical sources, critical evaluation of digital resources, transformation of visual evidence into learning tasks, reflective analysis and academic integrity. The content was structured as a system of five interrelated modules, and a pedagogical model comprising target, content, organisational and diagnostic blocks was supplemented with six methodological tools and supported by the MEROSNOMA mobile application. Historical thinking was assessed by cognitive, procedural and integrative criteria. At the end of the experiment, the proportion of students at the high level was 36.9% in the experimental group versus 26.2% in the control group, and Pearson’s χ^2 test confirmed statistically significant differences ($\chi^2 = 11.18–19.07 > 5.991$; $\alpha = 0.05$). The findings indicate that virtual museums become effective for developing historical thinking when embedded in a structured mechanism that moves students from describing exhibits to analysing them and transforming them into school learning tasks.

Keywords: Virtual museum; historical thinking; pre-service history teacher; pedagogical mechanism; pedagogical model; modular content; historical source analysis; digital heritage; assessment criteria.

Introduction

The digital transformation of education is bringing substantial changes to the content and forms of history teaching. Today’s history teacher is expected not only to know historical facts and dates but also to select digital sources, assess their reliability, adapt them to lesson objectives and organise methodological activities that develop pupils’ independent historical reasoning. Historical thinking – the ability to perceive historical events and phenomena in

chronological sequence, to identify cause-and-effect relationships, to analyse sources critically, to compare different perspectives and to draw evidence-based conclusions – is regarded as one of the core professional competencies of a history teacher [1; 2].

In international scholarship, the development of historical thinking has been widely studied within source-based approaches, including the "Big Six" historical thinking concepts proposed by P. Seixas and T. Morton [2], S. Wineburg's approach of "reading like a historian" [3], and the SCIM-C strategy developed by D. Hicks, P. Doolittle and E. Ewing [4]. At the same time, the digitisation of museum collections has turned virtual museums into a self-standing educational environment for studying historical and cultural heritage [5; 6; 7]. However, the availability of virtual museum resources does not in itself produce pedagogical outcomes: students frequently confine themselves to describing an exhibit without analysing its historical context, its reliability as a source or its place within a learning task.

1.1. Literature review

The virtual form of the museum was initially defined as a knowledge base and communication system that presents objects and information via the Internet [7]. The concept was subsequently extended to denote an environment for preserving and interpreting digital heritage and for interactive engagement with users [5]. P. F. Marty demonstrated the role of museum websites in learning activities before and after a physical visit [6], while J. H. Falk and L. D. Dierking interpreted the museum experience as the interplay of personal, socio-cultural and physical contexts [12].

In the context of teacher education, Turkish researchers F. Kayaalp, Z. Başcı Namlı and E. Meral established the pedagogical benefits of virtual museum design by pre-service social studies teachers [13], whereas K. Ulusoy [14] and C. Utkugün [15] examined students' and pre-service teachers' views on virtual museums, noting their motivational and visual advantages alongside insufficient methodological preparation. The European Framework for the Digital Competence of Educators (DigCompEdu) requires teachers to select and adapt digital resources and to support learners' critical thinking [16].

From the standpoint of historical thinking theory, working with sources is its central component. S. Wineburg distinguishes the operations of sourcing, contextualisation and corroboration [3], while the SCIM-C strategy offers a sequential procedure of summarising, contextualising, inferring, monitoring and corroborating [4]. In Uzbekistan, the tasks of digitising museum collections and using them in education are set out in national regulatory documents [8; 9]. Local studies have substantiated the priority principles for improving the professional competence of future history teachers on the basis of historical thinking [10] and the didactic functions of virtual educational museums in developing digital competencies [11].

The review shows that existing studies address either the educational potential of virtual museums or the general methodology of developing historical thinking, but treat these separately. A mechanism that integrates the two through the methodological activity of the pre-service history teacher, with modularised content and criterion-based measurement of outcomes, has not yet been proposed. In particular, virtual museums have not been examined

as an integrated mechanism linked to a dedicated modular content, a pedagogical model and assessment criteria for developing the historical thinking of pre-service history teachers.

1.2. Aim of the study

The aim of this study is to develop a mechanism for fostering the historical thinking of pre-service history teachers through virtual museums and to substantiate its effectiveness through a pedagogical experiment. In this article, the concepts of "pedagogical mechanism" and "pedagogical model" are used in a hierarchical relationship: the mechanism is understood as an interrelated system of activity comprising goals, modular content, didactic conditions, methods and tools, diagnostics and feedback; the model is regarded as a constituent part of the mechanism that represents its structure and the links between its blocks.

2. MATERIALS AND METHODS

2.1. Research design and methodological framework

The methodological basis of the study comprised systemic, competency-based, activity-based, context-and-source, constructive, axiological and reflective approaches. Theoretical methods included comparative and critical analysis of pedagogical, psychological and regulatory sources, modelling and generalisation. Empirical methods included pedagogical observation, interviews, questionnaires, testing, expert evaluation and a pedagogical experiment.

2.2. Participants and setting

The pedagogical experiment was conducted in the 2024–2026 academic years in the History Education programmes of Kokand, Bukhara and Termez State Universities (Uzbekistan) in three stages: ascertaining, formative and final. A total of 438 students took part: 217 in the experimental groups (EG) and 221 in the control groups (CG).

2.3. Intervention

In the control groups, classes were conducted in the traditional way. In the experimental groups, classes were organised on the basis of the proposed mechanism, drawing on the virtual exhibitions of the State Museum of the History of the Timurids and the British Museum included in the catalogue of the MEROSNOMA mobile application. The content, model and tools of the intervention are described in Section 3.

2.4. Assessment criteria and instruments

The level of historical thinking was assessed according to three criteria: (a) cognitive – readiness to use virtual museums and the ability to relate virtual materials to the content of history as a school subject; (b) procedural – integrating exhibits into the teaching process, creating a lesson scenario based on a virtual museum and analysing it; and (c) integrative – establishing logical connections between historical facts and exhibits and drawing conclusions grounded in sources. Each criterion was measured through five indicators at three levels: low, medium and high.

2.5. Data analysis

The statistical significance of differences between the groups was tested with Pearson's χ^2 test for a three-category ordinal scale at a significance level of $\alpha = 0.05$ (degrees of freedom df = 2; critical value $\chi^2_{0.05} = 5.991$). The null hypothesis stated that the distributions of levels in the EG and CG do not differ.

3. RESULTS

3.1. Didactic potential of virtual museums

Based on the analysis and observations, the potential of the virtual museum for developing historical thinking was generalised into five priority areas: (1) working with historical sources – analysing an exhibit as a primary source in terms of its author, period and context; (2) critical evaluation of digital resources – verifying the reliability of the platform, the description and the digital copy; (3) transforming visual evidence into learning tasks – designing a problem question, case or comparative task based on an exhibit; (4) reflective analysis – evaluating and improving one's own methodological decisions; and (5) academic integrity – citing digital sources correctly and respecting copyright. These areas are regarded as conditions for transforming the virtual museum from a "demonstration tool" into a space for historical thinking.

3.2. Modular content

The content was designed not as a collection of separate topics but as a system of five modules that build on one another sequentially (Table 1). The modules lead the student from initial orientation to the independent creation of a methodological product.

Table 1. Modular content for developing historical thinking

Module	Main content	Component developed
1. Virtual museum and digital heritage	Familiarisation with national and foreign virtual exhibitions and digital archives; compiling a resource catalogue	Digital source literacy
2. Analysis of historical sources and exhibits	Completing an exhibit passport and a source–context table based on the SCIM-C strategy and S. Wineburg's approach	Analytical-interpretive thinking
3. Virtual excursion scenario	Designing an excursion route and tasks aligned with a school curriculum topic	Methodological-design thinking
4. Interactive methods	Case study, project, academic debate, historical time navigation, concept mapping; linking micro-teaching with virtual resources	Problem-based pedagogical thinking
5. E-portfolio	Compiling completed work, self-assessment, tracking developmental dynamics	Reflective thinking

Source: developed by the author.

3.3. Pedagogical model and methodological toolkit

The model consists of target (social demand, aim, objectives), content (stages, competencies, principles, pedagogical conditions, approaches), organisational (forms, tools, methods and technologies) and diagnostic (criteria and levels) blocks. Its novelty lies in six methodological tools that constitute its practical part: the exhibit passport (a description of the exhibit's origin, period, function and reliability); the source–context table (comparison of the exhibit with written sources and the historical situation); the problem-question constructor (an algorithm for formulating questions such as "Why?", "For what reason?", "What if … had not happened?"); the virtual excursion scenario; the e-portfolio; and the assessment rubric.

On the basis of the model, four specific (applied) strands of the mechanism were implemented: exhibit–source analysis (analytical-interpretive component); methodological transformation – turning knowledge acquired at university into a fragment of a school lesson (methodological-historical component); creation of virtual quests and excursions (problem-based pedagogical component); and multimedia integration (digital-methodological component). Each strand concluded with micro-teaching and reflection.

To implement the content digitally, the MEROSNOMA mobile application was developed. The application comprises a catalogue of virtual museums, a source analysis and case section, a virtual quest module and a profile-reflection section, and supports the sequence "source analysis – methodological transformation – virtual quest – reflection".

3.4. Experimental results

The aggregated indicators for the three criteria at the end of the experiment are presented in Table 2.

Table 2. Levels of historical thinking at the end of the experiment (mean across three criteria)

Level	Experimental group (n = 217)		Control group (n = 221)	
	n	%	n	%
High	80	36.9	58	26.2
Medium	93	42.9	91	41.2
Low	44	20.3	72	32.6

Source: calculated by the author from the experimental data.

In the experimental group, the proportion of students at the high level was 10.7 percentage points higher than in the control group, and the proportion at the low level was 12.3 percentage points lower. In the groups of the final stage (2025–2026 academic year), the initial and final states were compared (Table 3).

Table 3. Dynamics of levels at the final stage, %

Level	Control group (n = 73)		Experimental group (n = 72)	
	before	after	before	after
Low	45.21	38.36	33.33	13.89
Medium	31.51	34.25	43.06	40.28
High	23.28	27.39	23.61	45.83

Source: calculated by the author from the experimental data.

In the experimental group, the proportion of students at the high level increased by 22.22 percentage points, whereas in the control group the increase was 4.11 percentage points; the proportion at the low level decreased by 19.44 and 6.85 percentage points, respectively. At the beginning of the experiment, the differences between the groups were not statistically significant at any of the three stages ($\chi^2 = 4.22; 3.25; 2.60 < 5.991$), i.e. the groups were homogeneous at baseline. At the end of the experiment, the χ^2 values exceeded the critical value at all stages ($\chi^2 = 12.85; 11.18; 19.07 > 5.991$). Consequently, the null hypothesis was rejected and the alternative hypothesis was accepted at the 95% confidence level: the positive changes in the experimental group are not random and are attributable to the effect of the proposed mechanism.

4. DISCUSSION

The results are consistent with international findings that the educational effect of virtual museums depends on the pedagogical structure in which they are embedded [13; 14; 15]. In particular, the greatest change in the experimental group was observed in the procedural and integrative criteria – integrating exhibits into the teaching process and establishing logical connections between historical facts and exhibits. This suggests that the exhibit passport and the source–context table, grounded in the SCIM-C strategy and S. Wineburg's approach, move students from description to analysis [3; 4].

The distinctive feature of this study compared with international practice is that the virtual museum is treated as a two-sided object for the pre-service teacher: the student first analyses a source as a historian and then transforms it into a learning task for school pupils. The stages of methodological transformation and micro-teaching ensure precisely this second side – the conversion of historical thinking into professional-methodological thinking. In this sense, the proposed mechanism complements the competence of selecting and adapting digital resources emphasised in the DigCompEdu framework [16] with the subject-specific features of history.

The study has several limitations. The experiment was limited to three universities and relied mainly on the resources of two virtual platforms; the long-term stability of historical thinking (during teaching practice and the first years of employment) was not examined separately. Future research should test the mechanism in other degree programmes and in in-service training for school teachers, and introduce a criterion-based automated assessment function into the MEROSNOMA application.

5. CONCLUSION

The study led to the following conclusions:

1. The didactic potential of virtual museums for developing the historical thinking of pre-service history teachers was specified by prioritising work with historical sources, critical evaluation of digital resources, transformation of visual evidence into learning tasks, reflective analysis and academic integrity.
2. The content for developing historical thinking was refined as a coherent system of modules: "Virtual Museum and Digital Heritage", "Analysis of Historical Sources and Exhibits", "Virtual Excursion Scenario", "Interactive Methods" and "E-Portfolio".
3. The pedagogical model was enriched with a set of methodological tools – the exhibit passport, the source–context table, the problem-question constructor, the virtual excursion scenario, the e-portfolio and the assessment rubric – and substantiated as the structural basis of the pedagogical mechanism.
4. Cognitive, procedural and integrative criteria for determining the level of historical thinking were developed. The experimental results ($\chi^2 = 11.18–19.07 > 5.991$; $\alpha = 0.05$) statistically confirmed the effectiveness of the proposed mechanism.

The proposed mechanism and methodological tools can be used in teaching the course "Methods of Teaching History", in organising the teaching practice of pre-service history teachers, and in in-service training courses for history teachers.

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