Global Conference on Multidisciplinary Research and Innovation
Hosted Online from Berlin, Germany
Date: 2nd May, 2026
Website: https://econferencia.com

DESIGNING A DIGITAL LEARNING ENVIRONMENT BASED ON INTERDISCIPLINARY INTEGRATION AND CLOUD TECHNOLOGIES IN THE PREPARATION OF FUTURE PRIMARY SCHOOL TEACHERS

Xomidov Zohidjon Adhamjon o‘g‘li
Independent researcher, Kokand State University

Abstract

The article substantiates a model for designing a digital learning environment for the subject “Primary Education Informatics and its Teaching Methodology” on two mutually reinforcing foundations: interdisciplinary integration and cloud technologies. The author argues that the software and methodological support of this subject cannot be reduced to a set of digital tools, because the professional task of a primary school teacher is not to teach informatics as an isolated discipline but to use informatic means across the whole of the primary curriculum. Proceeding from this premise, a five-layer architecture of the environment is proposed, comprising conceptual-target, content-integration, technological-operational, communicative-reflexive and diagnostic-corrective layers, and eight design principles are formulated. The functions of cloud services are described not as storage facilities but as an infrastructure of joint pedagogical design, in which students produce, test and revise methodological products for real primary classes. The article also presents typical instructional scenarios, the conditions of effective functioning and the criteria for judging productivity. The results may be used in designing curricula, digital resources and methodological guidelines for pedagogical higher education institutions.

Keywords: Digital learning environment, interdisciplinary integration, cloud technologies, primary education informatics, future primary school teachers,

methodological support, instructional design, computational thinking, teacher digital competence.

Introduction

The preparation of primary school teachers has entered a period in which digital tools are no longer an optional supplement to the curriculum but a condition of professional adequacy. The teacher is expected to combine a digital resource, a printed textbook and a practical activity within a single instructional logic, and to do so across four or five subject areas in one working day. The subject "Primary Education Informatics and its Teaching Methodology" is central here, being the only course in which the future teacher studies both the content of informatics and the methodology of transmitting it to children of seven to eleven.

Practice shows, however, that the support of this subject in many pedagogical institutions has been assembled additively rather than designed: separate resources are introduced course by course, each with its own interface, file conventions and assessment logic, and the student is left to integrate them personally. The consequence is well documented: graduates who are technically competent users of digital tools nevertheless fail to translate that competence into instructional decisions in the classroom [1; 9]. The gap is not technological but design-related: it appears wherever the environment in which future teachers study is structured differently from the one in which they will later teach.

The purpose of the article is to substantiate a model of a digital learning environment for this subject, in which interdisciplinary integration provides the content logic and cloud technologies the operational infrastructure. It addresses three questions: what architecture such an environment should have, what principles should govern its design, and what instructional scenarios make its integrative potential work.

Literature review

The theoretical framework of the study rests on several established lines of research. The first is the conceptualisation of teacher knowledge as an intersection of technological, pedagogical and content components, which established that competence in a digital tool and competence in teaching with it are distinct constructs requiring distinct means of development [1]. Later refinements showed that the technological component is subject-specific rather than generic, and that its assessment requires tasks in which the student designs instruction rather than describes it [2]. The consequence for design is direct: the environment must be a workshop, not a library.

The second line concerns cloud computing in education. Early analyses emphasised scalability and reduced infrastructure costs [3], while later reviews shifted the emphasis towards pedagogical affordances: simultaneous authorship, transparent revision history, distributed access to shared artefacts and the embedding of assessment into the process of production rather than the product [4]. These affordances, not storage capacity, make cloud technologies suitable as the operational basis of teacher preparation.

The third line is research on curriculum integration and twenty-first century competences, which has shown that integrated curricula support transfer more reliably than parallel subject teaching, provided that the integration rests on genuine conceptual links rather than thematic coincidences [6; 12]. Related work on computational thinking has established that decomposition, abstraction, pattern recognition and algorithmisation are not confined to programming and can be developed through mathematics, language and natural science content at the primary level [10; 11]. Interdisciplinary integration in primary informatics thus acquires a firm conceptual basis: informatics supplies the primary school with ways of thinking, not merely with devices.

Finally, frameworks of teacher digital competence describe the target profile towards which the environment should be oriented — professional engagement, the use and creation of digital resources, digital assessment, learner empowerment and the facilitation of learners' own digital competence [7; 8] — while research on learning design supplies the instrument for realising it: instructional design treated as an iterative, evidence-informed and shareable professional activity [13; 14].

Methods

The study is theoretical and design-oriented. It combines analysis of scholarly sources, comparative examination of the software and methodological support currently used in the subject, and pedagogical modelling. The architecture proposed below was derived by identifying the professional functions that a primary school teacher performs with digital means and determining, for each function, the type of learning activity and the type of digital service that support its formation. The model was then refined through expert discussion with methodologists and practising primary school teachers and through trial implementation of individual scenarios in seminar sessions.

Results and discussion

The architecture of the environment. The environment is organised into five interconnected layers, each answering a different design question. The omission of any one produces a characteristic dysfunction: without the conceptual-target layer the environment becomes a collection of tools, without the diagnostic-corrective layer a space of activity without evidence, and without the communicative-reflexive layer a site of individual consumption instead of collaborative pedagogical design.

Layer	Functional purpose	Cloud-based realisation
Conceptual-target layer	Fixes the integrated learning outcomes and the profile of the informatic competence of a primary school teacher	Shared competence matrix, mapped to course units and stored as a living document
Content-integration layer	Links informatics content with mathematics, native language, natural science and technology of the primary school	Cross-referenced repository of integrated tasks, digital textbooks and open educational resources
Technological-operational layer	Provides the tools with which students design, test and share methodological products	Cloud office suites, block-based programming environments, LMS, collaborative boards, version control
Communicative-reflexive layer	Organises joint work, peer review and reflection of the students	Shared portfolios, comment threads, video-recorded micro-teaching with time-coded feedback
Diagnostic-corrective layer	Collects data on progress and returns it to the teacher and to the student	Automated quizzes, rubric-based assessment, learning analytics dashboards

Interdisciplinary integration as the content logic. Integration in this model operates at three levels of depth. At the level of tools, an informatics application is used to solve a task belonging to another subject: a spreadsheet organises the results of a natural-science observation, a graphics editor illustrates a text read in the native language lesson. At the level of methods, a procedure formed in informatics is transferred to another subject: the decomposition of a problem into steps becomes a technique for solving a compound arithmetical task, and the construction of an algorithm becomes a technique for planning a written composition. At the level of concepts, the subjects share a common object of study, as when the notion of a sequence is developed simultaneously through numerical patterns in mathematics, the ordering of events in a narrative, and the linear execution of instructions in a block-based programming environment.

Only the third level produces stable transfer, and it is also the level least represented in existing methodological support. Accordingly, conceptual-type integrated tasks constitute the core of the students' practical work, while tool-level and method-level integration serve as preparatory stages. Every task in the repository is described by fixed parameters: grade, subjects involved, shared concept, digital means, expected outcome in each subject and assessment criterion.

Cloud technologies as the operational infrastructure. The function of cloud services in this environment is to make the process of methodological design visible and joint. Four functional groups are distinguished. Collaborative authoring services allow a group of students to construct a lesson plan simultaneously, with each participant's contribution retained in the revision history, which converts group work from an administrative arrangement into an assessable process. Repository services hold the accumulated tasks, resources and student products, whose value grows cumulatively across cohorts. Learning management services carry the sequence of study, deadlines and automated assessment, while analytical services aggregate the resulting data and return it in a form usable for instructional decisions [4; 15].

Design principles

Eight principles govern the construction and operation of the environment. Professional authenticity requires every task performed in the environment to correspond to a task a primary school teacher genuinely performs. Pedagogical primacy requires the choice of a digital means to follow from an instructional purpose and never to precede it. Integrative sufficiency requires each integrated task to be justified in every subject it involves, so that no subject is reduced to decoration. Layered accessibility requires the environment to remain workable under limited connectivity, through offline-capable applications and lightweight formats. Productive collaboration requires group tasks to be structured so that individual contribution is both necessary and traceable. Reflective transparency requires students to see the criteria and results of assessment and to comment on the work of their peers. Cumulative growth requires the products of each cohort to remain in the repository as material for the next. Adaptive support requires differentiated assistance for students with unequal initial preparation.

Instructional scenarios

The architecture is realised through four typical scenarios. In collaborative lesson design, a group of four students builds an integrated lesson for a given grade around a shared concept, distributing the roles of content specialist, methodologist, resource designer and assessor, and submits the plan with the resources it requires. In virtual methodological analysis, students examine a recorded lesson fragment against a rubric, annotate it collectively with time-coded comments and formulate an alternative instructional decision. In resource construction, each student produces a digital resource for a specific primary class outcome and subjects it to structured peer review before revision. In data-informed correction, students analyse the results of a diagnostic task performed by real pupils and redesign the lesson segment on the basis of the errors detected.

Across all four scenarios the sequence remains constant: design, realisation, testing, evidence, revision. It embodies the central idea of the model — that a future teacher acquires informatic competence not by studying digital means but by producing instruction with them and examining its consequences [9; 13].

Conditions and evaluation criteria

The functioning of the environment depends on four conditions: the methodological preparedness of the teaching staff, since joint design requires the instructor to supervise professional work rather than transmit content; the coordination of the syllabuses of the integrated subjects, without which conceptual-level tasks cannot be scheduled coherently; a technical baseline that includes stable access to the selected cloud services and a defined offline alternative for each; and a clear policy of authorship and data use, necessary both for the fairness of assessment and for the protection of the data of pupils involved in trial teaching.

Productivity is judged by four criteria: the cognitive criterion, concerning the quality of knowledge of informatics content and its teaching methodology; the design criterion, concerning the pedagogical quality of the methodological products created, evaluated by expert rubric; the transfer criterion, concerning the application of informatic methods in other primary subjects; and the reflexive criterion, concerning the accuracy with which students diagnose their own instructional decisions. Together these criteria distinguish genuine professional growth from mere familiarity with digital tools — a distinction conventional assessment of the subject rarely captures [7; 8].

Conclusion

The software and methodological support of the subject “Primary Education Informatics and its Teaching Methodology” becomes effective when it is designed as a single environment rather than accumulated as a set of resources. Interdisciplinary integration supplies its content logic, since the professional destination of the future primary school teacher is the whole of the primary curriculum and not informatics alone, while cloud technologies supply its operational infrastructure, making joint design, transparent authorship, cumulative accumulation of products and evidence-based assessment technically possible.

The five-layer architecture, the eight design principles and the four instructional scenarios proposed in the article constitute a coherent basis for the practical reconstruction of the subject's support system. Their implementation requires coordinated syllabuses, methodologically prepared staff and a defined technical baseline. Further research should establish quantitative indicators of the model's effectiveness through experimental work with successive cohorts and examine the sustainability of transfer effects in the first years of independent teaching practice.

REFERENCES

1. Mishra P., Koehler M. J. Technological pedagogical content knowledge: A framework for teacher knowledge // Teachers College Record. – 2006. – Vol. 108, No. 6. – P. 1017–1054.
2. Angeli C., Valanides N. Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK // Computers & Education. – 2009. – Vol. 52, No. 1. – P. 154–168.
3. Sultan N. Cloud computing for education: A new dawn? // International Journal of Information Management. – 2010. – Vol. 30, No. 2. – P. 109–116.
4. González-Martínez J. A., Bote-Lorenzo M. L., Gómez-Sánchez E., Cano-Parra R. Cloud computing and education: A state-of-the-art survey // Computers & Education. – 2015. – Vol. 80. – P. 132–151.
5. Hew K. F., Brush T. Integrating technology into K–12 teaching and learning: Current knowledge gaps and recommendations for future research // Educational Technology Research and Development. – 2007. – Vol. 55. – P. 223–252.
6. Voogt J., Roblin N. P. A comparative analysis of international frameworks for 21st century competences // Journal of Curriculum Studies. – 2012. – Vol. 44, No. 3. – P. 299–321.
7. Redecker C. European Framework for the Digital Competence of Educators: DigCompEdu. – Luxembourg: Publications Office of the European Union, 2017. – 95 p.

8. Falloon G. From digital literacy to digital competence: The teacher digital competency (TDC) framework // Educational Technology Research and Development. – 2020. – Vol. 68. – P. 2449–2472.
9. Tondeur J., van Braak J., Sang G., Voogt J., Fisser P., Ottenbreit-Leftwich A. Preparing pre-service teachers to integrate technology in education: A synthesis of qualitative evidence // Computers & Education. – 2012. – Vol. 59, No. 1. – P. 134–144.
10. Wing J. M. Computational thinking // Communications of the ACM. – 2006. – Vol. 49, No. 3. – P. 33–35.
11. Grover S., Pea R. Computational thinking in K–12: A review of the state of the field // Educational Researcher. – 2013. – Vol. 42, No. 1. – P. 38–43.
12. Drake S. M., Reid J. L. Integrated curriculum as an effective way to teach 21st century capabilities // Asia Pacific Journal of Educational Research. – 2018. – Vol. 1, No. 1. – P. 31–50.
13. Laurillard D. Teaching as a Design Science: Building Pedagogical Patterns for Learning and Technology. – New York: Routledge, 2012. – 258 p.
14. Salmon G. E-tivities: The Key to Active Online Learning. 2nd ed. – London: Routledge, 2013. – 240 p.
15. Bower M. Deriving a typology of Web 2.0 learning technologies // British Journal of Educational Technology. – 2016. – Vol. 47, No. 4. – P. 763–777.