



Generative AI-Assisted Co-Design of Gamified Computational Thinking Activities: Feasibility and Cognitive Load in Low-Resource Basic Education

Andrés Felipe Vergara Rodríguez¹ , Juan Carlos Giraldo Cardozo^{2*}

¹Bachelor of Science in Computer Science with emphasis in Audiovisual Media, Universidad de Córdoba, Montería, Córdoba, Colombia. Email: andreskronos@gmail.com

²Department of Educational Informatics, Faculty of Education and Humanities, Universidad de Córdoba. Email: jgiraldo@correo.unicordoba.edu.co

*Corresponding author



Copyright 2026 International Journal of Contemporary Research and Review. Licenced by Creative Commons Attribution-Non Commercial- No Derivatives (CC BY-NC-ND) 4.0 International Licenses.

<https://creativecommons.org/licenses/by-nc-nd/4.0/>

Abstract

This study reports the design and exploratory evaluation of a gamified learning environment in which generative artificial intelligence was used as a teacher-facing instructional co-design tool, not as a real-time intelligent tutor. The intervention combined problem-based learning, interactive narratives, Moodle deployment, and H5P learning objects in a public school in Montería, Colombia. A technical action-research design was implemented with 113 basic education students in two classroom scenarios: a sixth-grade Technology and Informatics scenario based on ad hoc fantasy narratives for spreadsheet logic, and a ninth-grade Spanish Language scenario based on a literary frame linked to El Periquillo Sarniento. Data sources included teacher appraisal with the COdA learning-object quality framework, student Likert-type perception surveys, Moodle/H5P interaction records, classroom observations, and teacher interviews. The results indicate that the model is feasible and pedagogically useful in low-resource contexts. COdA appraisal showed strong ratings in interactivity, format and design, accessibility, reusability, and interoperability, while also identifying the need for clearer learning objectives and stronger curricular alignment. Student perceptions were more favorable in the sixth-grade scenario than in the ninth-grade scenario. Rather than treating this pattern as a controlled grade-level effect, the article interprets it as a design lesson: dense literary mediation may increase extraneous cognitive load when paired with algorithmic vocabulary. The study concludes that generative artificial intelligence can accelerate human-curated instructional co-design, but the evidence is limited to feasibility, usability, engagement, and perception indicators. Future research should use validated computational-thinking instruments, control groups, and longitudinal designs.

Keywords: cognitive load; computational thinking; gamified learning; generative artificial intelligence; instructional co-design; learning objects

1. Introduction

Computational thinking has become a central educational construct because it supports the formulation, representation, and systematic solution of problems in technology-mediated societies [1,2]. In school settings, this construct includes operations such as decomposition, abstraction, pattern recognition, sequencing, algorithmic reasoning, and debugging. Its relevance in Colombian basic education is reinforced by curricular and public-policy orientations that call for early digital competencies, technological appropriation, innovation, and equity in access to digital learning opportunities [3,4].

Despite these policy orientations, many public-school classrooms still face a persistent gap between students' everyday digital experiences and the learning opportunities offered by traditional instruction. This gap is particularly visible in contexts marked by unstable connectivity, limited computer availability, uneven teacher preparation for digital design, and the need to transform passive technology use into structured learning activity. National digital-transformation and education-technology policies have therefore emphasized both the adoption of emerging technologies and the pedagogical conditions required for meaningful classroom appropriation [5,6].

Problem-based learning (PBL) offers a suitable pedagogical structure for this challenge because it organizes learning around situations that require inquiry, decision making, collaboration, and the application of knowledge [7,8]. Generative artificial intelligence can complement this approach by accelerating the creation of contextualized narratives, scenarios, prompts, images, and activity scripts. However, a central methodological distinction is required: using generative artificial intelligence to create or support educational materials is not equivalent to implementing an adaptive artificial-intelligence tutor that interacts with students in real time. The present study adopts the first approach. Artificial intelligence was used in the teacher-facing design

process, while students interacted with predesigned Moodle/H5P activities.

The purpose of this article is to present a methodologically cautious account of an action-research intervention that used generative artificial intelligence-assisted instructional co-design to create gamified narratives for computational-thinking exposure in basic education. The objectives were to: (a) characterize pedagogical elements of a PBL-based narrative strategy; (b) design and implement interactive learning objects with Moodle and H5P; and (c) examine instructional quality, usability, student engagement, and perceived clarity in two authentic classroom scenarios. The article does not claim causal evidence of computational-thinking gains. Its contribution lies in reporting feasibility, design quality, perception data, and cognitive-load considerations as a basis for subsequent controlled studies.

2. Theory

2.1 Computational thinking, problem-based learning, and gamified narratives

Computational thinking is not limited to programming syntax. It refers to a family of cognitive and representational practices that allow learners to define problems, model relevant elements, formulate stepwise procedures, identify patterns, and test solutions [1,2]. In basic education, this wider interpretation is pedagogically relevant because it enables teachers to introduce algorithmic reasoning through spreadsheets, digital stories, problem situations, puzzles, and other low-threshold environments before moving toward formal programming languages.

PBL supports computational-thinking exposure because it provides a meaningful problem structure. Instead of presenting isolated concepts, the teacher can place learners inside a challenge that requires them to interpret information, select procedures, test alternatives, and justify decisions [7,8]. Gamification adds a motivational layer through missions, characters, feedback moments, and progressive challenges [11]. When these elements are designed carefully, a narrative

environment can help learners perceive computational operations as purposeful actions within a problem situation rather than as decontextualized technical routines.

Digital storytelling has been used as a framework for connecting sequencing, creativity, and computational reasoning [12]. Recent studies also suggest that generative artificial intelligence can support narrative production, collaborative problem solving, and creative design when it remains pedagogically guided [9,10,13,14]. In early and basic education, narrative-based digital programs have been associated with coding practice and computational-thinking exposure [15]. These contributions support the design logic of the present study, but they do not remove the need for precise measurement of the construct being evaluated.

2.2 Generative artificial intelligence as an instructional co-design and authoring tool

The central technological premise of this study is that generative artificial intelligence can function as an instructional co-design and authoring tool. In this role, artificial intelligence assists the teacher or designer in generating scenarios, branching storylines, activities, examples, prompts, and visual assets. The teacher remains responsible for curricular alignment, human review, disciplinary accuracy, accessibility, and final pedagogical decisions. This human-in-the-loop logic is especially important because generative models can produce plausible but misaligned, overly complex, or inaccurate educational content.

This distinction is essential for interpreting the intervention. Students did not interact with a runtime artificial-intelligence tutor. They interacted with static or semi-branching learning objects produced through a prior design workflow and packaged in H5P. Therefore, the scientific value of the intervention lies in the documented feasibility of an artificial intelligence-assisted authoring pipeline for public education, not in evidence of real-time adaptive tutoring. In low-resource environments, this authoring perspective is significant because it may reduce the time and

technical expertise required to create multimodal interactive resources.

2.3 Learning-object quality and the scope of COdA appraisal

The COdA framework provides criteria for evaluating the quality of learning objects, including objectives and didactic coherence, content quality, reflection and innovation, interactivity and adaptability, motivation, format and design, usability, accessibility, reusability, and interoperability [16]. In this study, COdA was used as an expert appraisal tool to examine the instructional and technological quality of the Moodle/H5P learning objects. It should be interpreted as evidence of learning-object quality, ergonomic coherence, and pedagogical relevance. It is not a direct measure of student learning or computational-thinking performance.

2.4 Assessing computational thinking: performance measures, attitudinal scales, and perception data

Assessing computational thinking requires careful construct delimitation. Performance-based instruments, such as the Computational Thinking Test, present structured problems that estimate objective reasoning processes such as sequencing, loops, conditionals, and algorithmic logic [17]. These instruments are appropriate when the research objective is to estimate learning gain or cognitive performance. By contrast, self-report instruments such as the Computational Thinking Scales are designed to capture affective and dispositional dimensions, including self-efficacy, confidence, creativity, persistence, and attitudes toward computational tasks [18].

The present study did not administer the Computational Thinking Test or a validated Computational Thinking Scale. It used project-specific Likert-type perception items, classroom observations, and platform records. These sources are useful for documenting perceived clarity, motivation, usefulness, confidence toward the activity, usability, and navigation fluency. They are not sufficient to demonstrate causal improvement in computational-thinking

competence. Consequently, student responses are interpreted as attitudinal and perceptual indicators, not as objective evidence of algorithmic-performance gains.

2.5 Cognitive load and interdisciplinary narrative design

Cognitive load theory explains that working memory has limited capacity when learners process novel information [19]. Instructional design therefore needs to manage intrinsic load, associated with the inherent complexity of the task; extraneous load, generated by the way information is presented; and germane load, associated with schema construction and meaningful learning [20,21]. In technology-enhanced activities, interface complexity, unclear instructions, dense texts, and excessive media can increase extraneous load and reduce the cognitive resources available for the target learning process.

This theoretical lens is useful for interpreting differences between the two implementation scenarios without treating them as statistically equivalent groups. The sixth-grade activities used ad hoc fantasy narratives designed directly around spreadsheet logic and basic formulas. The ninth-grade activities integrated computational-thinking language into a literary sequence based on *El Periquillo Sarniento*, a historically distant and linguistically demanding text. This design choice created an opportunity for interdisciplinary integration, but it also introduced a possible source of extraneous cognitive load because students had to process literary-historical complexity while simultaneously engaging with algorithmic concepts.

3. Materials and methods

3.1 Design, setting, and participants

The study adopted a technical action-research design, organized around iterative cycles of planning, action, observation, and reflection [24,25]. This design was selected because the intervention was implemented in an authentic school context and required progressive adjustments to technology availability, connectivity, classroom dynamics, and teacher feedback. The intervention was carried out in 2025 at Institución Educativa General Santander, a public school in Montería, Colombia.

The participants were 113 basic education students selected through convenience and purposive sampling. The sixth-grade scenario included 36 students from grade 6-3 in the area of Technology and Informatics. The ninth-grade scenario included 77 students from grades 9-1 and 9-2 in the area of Spanish Language. Two subject teachers participated in interviews and in the quality appraisal of the learning objects through the COdA framework. The study followed institutional authorization procedures, informed consent/assent procedures, confidentiality practices, and anonymized reporting of student data.

Because the two scenarios differed simultaneously in age group, subject area, narrative vehicle, sample size, and classroom conditions, they were not treated as statistically comparable cohorts. Their results are reported as two descriptive implementation scenarios that illuminate different design conditions rather than as evidence of a controlled grade-level effect.

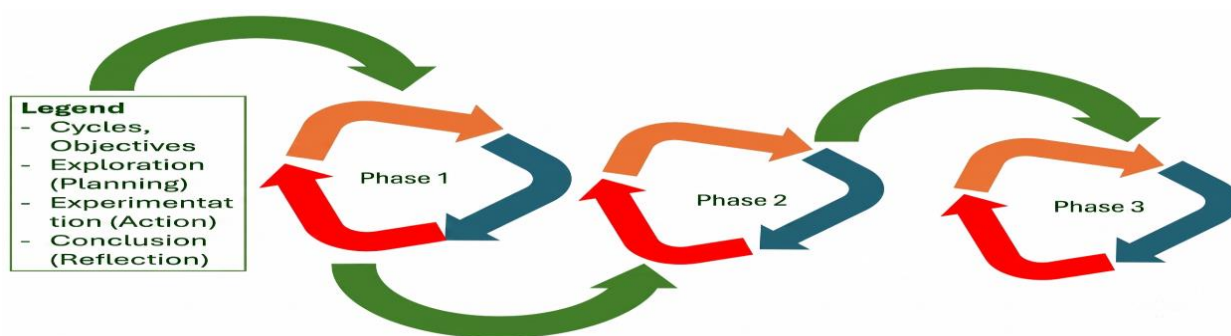


Fig. 1. Iterative action-research cycle used to organize the design, implementation, and reflection phases.

3.2 Artificial intelligence-assisted authoring pipeline

The intervention used an asynchronous instructional-design pipeline. First, prompts adapted from previous narrative-design experiences were refined to produce storylines, missions, characters, problem situations, and activity scripts. Second, text-generation tools such

as ChatGPT and Google AI Studio supported the creation and revision of narrative content. Third, image-generation tools, including Whisk, supported the production of static visual assets. Fourth, the generated materials were reviewed, edited, sequenced, and manually transferred into H5P learning-object templates. Finally, the H5P objects were hosted in Moodle for classroom use and tracking. Table 1 summarizes this workflow.

Table 1. Asynchronous generative artificial intelligence-assisted instructional co-design pipeline.

Phase	Teacher/designer action	Tool or resource	Student-facing output
Exploration	Reviewed candidate platforms and selected feasible resources for the school context.	SGames21 prompts, Moodle, H5P, ChatGPT, Google AI Studio, Whisk	Design criteria and prototype ideas
Authoring	Generated and refined narratives, characters, challenges, and visual assets.	Text and image generative artificial intelligence tools	Draft stories and images
Human review	Checked curricular alignment, language level, task coherence, and feasibility.	Teacher and researcher review	Curated instructional materials
Packaging	Transcribed and sequenced materials into interactive templates.	H5P interactive books and activities	Learning objects with finite interaction paths
Deployment	Hosted activities, enrolled students, and collected records.	Moodle LMS and H5P records	Student access, attempts, completion data, and survey responses

Note. The pipeline was asynchronous. The student-facing environment did not include real-time artificial-intelligence inference or adaptive tutoring.

3.3 Learning materials

The sixth-grade materials used fantasy narratives such as Guardianes de Ordenia and related medieval scenarios to introduce tables, rows, columns, formatting, spreadsheet formulas, and stepwise problem solving. These narratives were designed specifically for the learning objectives of Technology and Informatics. The ninth-grade

materials used a literary framing based on El Periquillo Sarniento, integrating chapters and interpretive tasks with computational-thinking vocabulary such as algorithms, variables, bugs, decomposition, and pattern recognition. Moodle provided access control and activity organization, while H5P provided interactive books, quizzes, matching activities, and embedded navigation sequences.

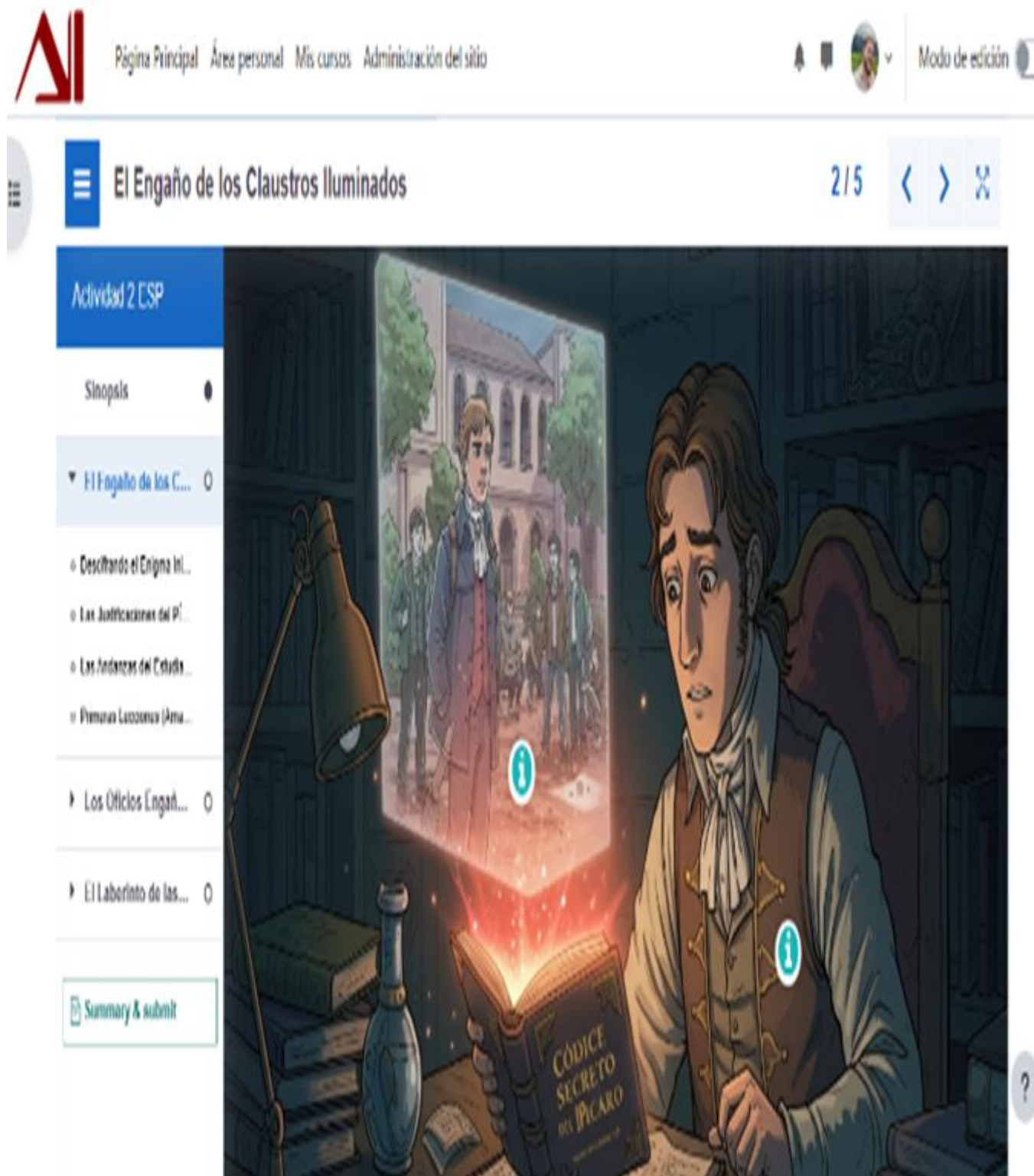


Fig. 2. Example of a narrative learning object integrated into Moodle/H5P. Text embedded in the image may be edited manually for final submission.

3.4 Instruments and data sources

Four data sources were used. First, student Likert-type surveys captured perceived clarity, motivation, usefulness, and confidence toward the activities after the intervention. These items were designed for the project and should not be read as a validated psychometric scale. Second, Moodle

and H5P records provided descriptive evidence of participation, attempts, and task completion. Third, classroom observations and field notes captured procedural questions, navigation difficulties, and engagement patterns. Fourth, teacher interviews and COdA appraisal were used to evaluate the instructional and technological quality of the learning objects.

Table 2. Data sources and construct scope.

Data source	Participants or units	Main construct	Interpretive scope
Student surveys	Likert 113 students	Perceived clarity, motivation, usefulness, and confidence toward the activities	Project-specific perception evidence; not a validated CTS or performance measure
Moodle/H5P records	Learning-object interactions	Attempts, task completion, navigation, and participation	Usability and engagement indicators
Classroom observations	Implementation sessions	Procedural doubts, autonomy in navigation, and interaction patterns	Qualitative evidence of platform habituation, task engagement, and navigation fluency
Teacher interviews and COdA appraisal	Two subject teachers and learning objects	Instructional quality, technological quality, and scalability	Learning-object quality appraisal; not direct student-learning measurement

3.5 Data analysis and ethical considerations

Survey and platform data were analyzed descriptively through averages, standard deviations, and scenario-level summaries. Because the study did not use randomization or equivalent groups, descriptive values were not treated as inferential comparisons. Qualitative information from observations and interviews was examined through open coding, content analysis, and reflective thematic analysis. Triangulation was used to compare survey tendencies, platform records, classroom observations, teacher interviews, and COdA appraisal results.

Ethical considerations included institutional authorization, informed participation, confidentiality, anonymized processing of student information, and a classroom implementation oriented to educational benefit. The intervention was designed to respect the school schedule and to

minimize risk by using curricular content and activities mediated by the teachers.

3.6 Inferential scope and methodological limitations

The action-research design provided ecological validity and allowed iterative improvement in a real classroom. However, it did not include random assignment, a concurrent control group, or longitudinal pre-test/post-test measurement with validated computational-thinking performance

instruments. The project-specific perception survey was not equivalent to a validated Computational Thinking Scale, and the COdA appraisal was conducted internally by participating subject teachers rather than by blind external reviewers. Accordingly, the results should be interpreted as evidence of instructional feasibility, learning-object quality, student

engagement, usability, perceived clarity, and navigation fluency. They should not be interpreted as causal proof of improvement in computational-thinking performance.

4. Results

4.1 Instructional design and implementation outputs

The intervention produced a complete set of Moodle/H5P learning objects that converted curricular topics into gamified narrative challenges. In grade 6, the learning objects presented spreadsheet concepts through a fantasy

setting in which students solved practical problems related to organization, calculation, inventory, and trade. In grade 9, the learning objects connected literary interpretation with computational-thinking vocabulary through missions based on El Periquillo Sarniento. The design process confirmed that generative artificial intelligence can accelerate the production of contextualized stories and images; nevertheless, manual review and transfer to H5P remained necessary.



Fig. 3. Students interacting with the Moodle/H5P learning environment during the implementation.

4.2 Teacher appraisal using CODa

The CODa-based appraisal showed a generally favorable evaluation of the learning objects. The strongest ratings appeared in technological and operational dimensions such as interactivity and adaptability, format and design, accessibility, reusability, and interoperability. These dimensions

were commonly rated between 4 and 5 on a five-point scale. Teachers also emphasized the portability of the model and its potential application in other areas of the curriculum. However, the appraisal also identified areas requiring improvement: clearer learning objectives, explicit performance expectations,

more intuitive authoring interfaces, stronger multimedia dynamism, and training for teachers

with lower initial digital competence.

Table 3. Teacher appraisal summary based on COdA criteria.

COdA criterion	Observed pattern	rating	Interpretation for article revision
Objectives and didactic coherence	Moderate: 3 and 3.5		Learning objectives and expected performance levels should be stated more explicitly at the start of each activity.
Content quality	Moderate to high: 3 and 4		Content was useful, but it requires stronger connection with contemporary topics and more dynamic media.
Reflection, critique, and innovation	Moderate to high: 3 and 4		Narratives can stimulate reflection when contextualization and teacher mediation are present.
Interactivity and adaptability	High: 4 and 5		The H5P structure supported interaction, although teachers requested richer media and better adaptation to profiles.
Motivation	High or qualitative favorable appraisal		Story and image integration was considered motivating, but static images reduced attention for some students.
Format and design	High: 4 and 5		The multimodal design was valued; clarity and organization should continue to be refined.
Usability	Moderate or qualitative concern		Platform navigation was acceptable for students but may require teacher training and a more self-explanatory interface.
Accessibility, reusability, and interoperability	High: mostly 4 and 5		The model was considered portable, reusable, and feasible for deployment through open educational technologies.

Note. The table summarizes two teacher appraisals and interview-based observations. COdA evaluates learning-object quality and should not be interpreted as a direct measurement of student learning outcomes.

4.3 Student perceptions, usability, and navigation fluency

Student surveys indicated generally favorable perceptions, especially in the sixth-grade scenario. The sixth-grade group reported a mean of 3.72/5 for perceived clarity of objectives and 3.85/5 for motivation in a selected Likert item. The ninth-

grade scenario showed lower and more variable perceived clarity, with a combined mean of 3.34/5. Motivation also showed greater dispersion in the ninth-grade groups. These values should be read as descriptive perception indicators, not as evidence that one grade level learned more than the other.

Table 4. Selected student perception indicators.

Indicator	Grade 6-3	Grade 9-1	Grade 9-2	Interpretation
Perceived clarity of objectives	Mean 3.72/5	Combined grade 9 mean 3.34/5	Combined grade 9 mean 3.34/5	The ninth-grade scenario required clearer framing and more explicit instructions.
Motivation for a selected activity item	Mean 3.85/5; SD 0.45	Mean 3.50/5; SD 0.60	Mean 3.75/5; SD 0.50	Motivation was more homogeneous in the sixth-grade scenario and more dispersed in the ninth-grade scenario.
Procedural questions during sessions	Decreased after initial activity	Decreased but with uneven engagement	Decreased but with uneven engagement	Evidence of interface habituation and navigational fluency, not direct cognitive-performance gain.

Note. Values are descriptive and come from project-specific Likert-type perception data. They should be read as indicators of engagement, perceived clarity, and usability, not as objective computational-thinking measures.

4.4 Two implementation scenarios and interdisciplinary design friction

The most analytically relevant pattern emerged from the different narrative conditions of the two implementation scenarios. Sixth-grade students interacted with fantasy narratives designed specifically around the target technological content. This alignment reduced unnecessary interpretive burden and allowed the activity to focus on spreadsheet logic, formulas, sequences,

and decision making. Ninth-grade students interacted with a literary narrative based on El Periquillo Sarniento while also being asked to use computational-thinking vocabulary. This produced a richer interdisciplinary ambition, but it also introduced a heavier interpretive demand. The data therefore suggest a design tension: narrative complexity can enrich contextualization, but it can also increase extraneous load when learners must process a historically distant literary text and algorithmic terminology at the same time.



Fig. 4. Ninth-grade classroom implementation. The activity combined literary content with computational-thinking vocabulary.



Fig. 5. Teacher mediation during the classroom implementation.

5. Discussion

5.1 Generative artificial intelligence as co-design infrastructure, not as runtime tutoring

The revised interpretation of the study positions generative artificial intelligence as co-design infrastructure. Its practical contribution was to accelerate the creation of narrative scenarios, images, and activity scripts that were later curated by the teacher and packaged in H5P. This role is pedagogically valuable because it lowers the production barrier for interactive digital materials, especially in schools where teachers may not have advanced software-development skills. However, the intervention did not implement adaptive tutoring, real-time feedback generation, cognitive diagnosis, or dynamic difficulty adjustment. Consequently, the evidence should support claims about authoring feasibility and instructional design, not claims about artificial-intelligence tutoring effects.

5.2 COdA appraisal: quality evidence and internal validation limits

The teacher appraisal results indicate that the generated learning objects reached acceptable levels of technological and pedagogical quality. High ratings in interactivity, format, accessibility, reusability, and interoperability support the idea that Moodle and H5P are viable platforms for deploying generative artificial intelligence-assisted resources in public-school contexts. However, this evidence must be interpreted with caution because COdA was applied internally by participating teachers, not by independent blind reviewers. Moreover, the more moderate ratings for objectives and didactic coherence are not a minor limitation; they identify the central condition for responsible use of generative artificial intelligence in instructional design: the teacher must curate, align, simplify, and evaluate AI-generated content before classroom deployment.

5.3 Narrative complexity, cognitive load, and the ninth-grade scenario

The ninth-grade scenario is central to the interpretive value of the article. Rather than

presenting the entire intervention as uniformly successful, the analysis recognizes a meaningful design tension: lower perceived clarity and more variable motivation appeared where computational-thinking concepts were embedded in a linguistically and historically demanding literary frame. Cognitive load theory provides a plausible explanation for this pattern. When learners are simultaneously required to interpret dense literary content and apply algorithmic terminology, extraneous load may consume working-memory resources that would otherwise support the construction of computational schemas [19-21].

The design implication is not that humanities content should be excluded from computational-thinking instruction. The implication is that interdisciplinary integration must be semantically calibrated. Literary, social-science, or civic narratives can be powerful vehicles for computational-thinking exposure when their language, context, and task structure reduce unnecessary interpretive friction. For adolescents, contemporary storytelling, design fiction, or sociotechnical dilemmas related to data, privacy, algorithms, and artificial intelligence may provide stronger alignment between narrative relevance and computational reasoning than historically distant texts with high lexical complexity.

5.4 Implications for public education in low-resource contexts

The intervention demonstrates a feasible model for public schools with limited infrastructure: generative artificial intelligence can be used outside the classroom to accelerate teacher-facing design, while Moodle and H5P can deliver the resulting materials through open and relatively lightweight technologies. This model avoids the infrastructural demands of real-time intelligent tutoring and is therefore suitable for contexts with unstable connectivity. Its value should not be located in the manual transfer of AI outputs into H5P, which is likely to be increasingly automated by LMS-integrated authoring tools, but in the human-in-the-loop process through which teachers transform AI-generated drafts into coherent,

accessible, and curriculum-aligned learning objects.

6. Conclusions and future work

The study designed and implemented an instructional strategy that used generative artificial intelligence to support teacher-facing co-design of gamified narratives for computational-thinking exposure in basic education. The strongest evidence concerns the feasibility of the authoring pipeline, the quality and portability of the Moodle/H5P learning objects, teacher appraisal of interactivity and reusability, and student perceptions of clarity, motivation, and usefulness. The results are especially encouraging in the sixth-grade scenario, where narrative design and curricular objectives were tightly aligned.

The interpretation avoids unsupported causal claims. The available data do not demonstrate objective gains in computational-thinking performance because the study did not use a control group, randomization, validated computational-thinking performance tests, or a standardized computational-thinking attitudinal scale. The contribution is therefore exploratory: it documents how generative artificial intelligence can support the design of interactive learning objects and how students and teachers respond to those resources in an authentic public-school setting.

The ninth-grade scenario provides a relevant design lesson. Interdisciplinary integration between language arts and computational thinking requires careful management of extraneous cognitive load. Future materials should use narratives that are culturally meaningful, cognitively accessible, and closely aligned with the target computational ideas, with explicit objectives and performance expectations from the start of the activity.

Future research should move in three directions. First, subsequent studies should compare this human-curated manual authoring workflow with emerging artificial-intelligence-to-H5P or LMS-integrated authoring tools that can automate part of the conversion from source material to

interactive activities [27,28]. Second, the static learning-object model should be connected with intelligent tutoring systems such as SGames21, where adaptive feedback, learner modeling, and metacognitive scaffolding can be implemented at runtime [22,23]. Third, future studies should use quasi-experimental or experimental designs with control groups, validated performance instruments such as the Computational Thinking Test, and standardized attitudinal scales such as the Computational Thinking Scales. This progression would make it possible to examine whether the feasibility, usability, and engagement indicators reported here translate into measurable computational-thinking gains over time.

Acknowledgments

The authors thank Institución Educativa General Santander, the participating students, and the subject teachers who supported the implementation and appraisal of the strategy. The authors also acknowledge Universidad de Córdoba for its academic support during the development of the undergraduate research project from which this article was derived.

Declaration of generative AI-assisted technologies in the writing process

During the preparation of this manuscript, ChatGPT was used to support English translation, structural adjustment to journal guidelines, and academic language editing. The authors reviewed, edited, and validated the content and assume full responsibility for the final version.

References

1. J.M. Wing, Computational thinking, *Commun. ACM* 49(3) (2006) 33-35. <https://doi.org/10.1145/1118178.1118215>.
2. S. Grover, R. Pea, Computational thinking in K-12: A review of the state of the field, *Educational Researcher* 42(1) (2013) 38-43. <https://doi.org/10.3102/0013189X12463051>.
3. Ministerio de Educación Nacional, Orientaciones curriculares para el área de Tecnología e Informática, Ministerio de

- Educación Nacional, Bogotá, 2022. https://www.colombiaaprende.edu.co/sites/default/files/files_public/2022-11/Orientaciones_Curricules_Tecnologia.pdf
4. Departamento Nacional de Planeación, Plan Nacional de Desarrollo 2022-2026: Colombia potencia mundial de la vida, DNP, Bogotá, 2023. <https://www.dnp.gov.co/plan-nacional-desarrollo/pnd-2022-2026>
5. Departamento Nacional de Planeación, CONPES 3975: Política Nacional para la Transformación Digital e Inteligencia Artificial, DNP, Bogotá, 2019. <https://colaboracion.dnp.gov.co/CDT/Conpes/Econ%C3%B3micos/3975.pdf>
6. Departamento Nacional de Planeación, CONPES 3988: Tecnologías para aprender: Política nacional para impulsar la innovación en las prácticas educativas a través de las tecnologías digitales, DNP, Bogotá, 2020. <https://colaboracion.dnp.gov.co/CDT/Conpes/Econ%C3%B3micos/3988.pdf>
7. H.S. Barrows, Problem-based learning in medicine and beyond: A brief overview, *New Directions for Teaching and Learning* 1996(68) (1996) 3-12. <https://doi.org/10.1002/tl.37219966804>.
8. V.J. Guamán Gómez, E.E. Espinoza Freire, Aprendizaje basado en problemas para el proceso de enseñanza aprendizaje, *Revista Universidad y Sociedad* 14(2) (2022) 124-131. <https://rus.ucf.edu.cu/index.php/rus/article/view/2684>
9. R. Yılmaz, F.G. Karaoğlu Yılmaz, The effect of generative artificial intelligence (AI)-based tool use on students' computational thinking skills, programming self-efficacy and motivation, *Computers and Education: Artificial Intelligence* 4 (2023) 100147. <https://doi.org/10.1016/j.caeai.2023.100147>
10. C.K.Y. Chan, W. Hu, Students' voices on generative AI: Perceptions, benefits, and challenges in higher education, *International Journal of Educational Technology in Higher Education* 20 (2023) 43. <https://doi.org/10.1186/s41239-023-00411-8>.
11. S. Deterding, D. Dixon, R. Khaled, L. Nacke, From game design elements to gamefulness: Defining gamification, in: *Proceedings of the 15th International Academic MindTrek Conference, ACM, New York, 2011*, pp. 9-15. <https://doi.org/10.1145/2181037.2181040>.
12. M. Kordaki, P. Kakavas, Digital storytelling as an effective framework for the development of computational thinking skills, in: *EDULEARN17 Proceedings, IATED, 2017*, pp. 6325-6335. <https://doi.org/10.21125/edulearn.2017.2435>.
13. X. Wei, L. Wang, L.-K. Lee, R. Liu, The effects of generative AI on collaborative problem-solving and team creativity performance in digital story creation: An experimental study, *International Journal of Educational Technology in Higher Education* 22 (2025) 23. <https://doi.org/10.1186/s41239-025-00526-0>.
14. M.Á. Navas-Martín, T. Cuervo-Vilches, Discurso grupal basado en narrativas generadas por inteligencia artificial como metodología activa en la enseñanza en arquitectura, *Innovación Educativa en Edificación* 8(1) (2024) 61-67. <https://doi.org/10.20868/abe.2024.1.5234>.
15. Ş. Metin, D. Kalyenci, M. Başaran, E. Relkin, Design-based digital story program: Enhancing coding and computational thinking skills in early childhood education, *Early Childhood Education Journal* 53 (2025) 2255-2274. <https://doi.org/10.1007/s10643-024-01728-3>.
16. A. Fernández-Pampillón Cesteros, E. Domínguez Romero, I. de Armas Ranero,

- Herramienta de evaluación de la calidad de objetos de aprendizaje (COdA), Universidad Complutense de Madrid, Madrid, 2012. <https://eprints.ucm.es/12533/>.
17. M. Román-González, J.-C. Pérez-González, C. Jiménez-Fernández, Which cognitive abilities underlie computational thinking? Criterion validity of the Computational Thinking Test, *Computers in Human Behavior* 72 (2017) 678-691. <https://doi.org/10.1016/j.chb.2016.08.047>.
 18. Ö. Korkmaz, R. Çakır, M.Y. Özden, A validity and reliability study of the Computational Thinking Scales (CTS), *Computers in Human Behavior* 72 (2017) 558-569. <https://doi.org/10.1016/j.chb.2017.01.005>.
 19. J. Sweller, Cognitive load during problem solving: Effects on learning, *Cognitive Science* 12(2) (1988) 257-285. https://doi.org/10.1207/s15516709cog1202_4.
 20. F. Paas, A. Renkl, J. Sweller, Cognitive load theory and instructional design: Recent developments, *Educational Psychologist* 38(1) (2003) 1-4. https://doi.org/10.1207/S15326985EP3801_1.
 21. J.J.G. van Merriënboer, J. Sweller, Cognitive load theory and complex learning: Recent developments and future directions, *Educational Psychology Review* 17 (2005) 147-177. <https://doi.org/10.1007/s10648-005-3951-0>.
 22. J.C. Giraldo, M.F. Caro, C.C. Lengua, ¿Cómo empoderar la creatividad educativa? Sistema tutor inteligente SGames21 y el aprendizaje contextualizado, in: XI Simposio Internacional de Currículo y Políticas Educativas, Santa Marta, Colombia, 2024. https://eventos.unimagdalena.edu.co/Content/ArchivosPublicaciones/Publicacion_1029/documento_2_20241114152123.681.pdf
 23. M. F. Caro, D. P. Josyula, D. P. Madera, C. M. Kennedy, and A. A. Gómez, "The CARINA metacognitive architecture," *International Journal of Cognitive Informatics and Natural Intelligence (IJCINI)*, vol. 13, no. 4, pp. 71–90, Oct. 2019, <https://doi.org/10.4018/IJCINI.2019100104>
 24. J. Elliott, *La investigación-acción en educación*, Ediciones Morata, Madrid, 2010.
 25. R. Hernández Sampieri, C. Mendoza, *Metodología de la investigación: Las rutas cuantitativa, cualitativa y mixta*, McGraw-Hill, México, 2018.
 26. UNESCO, *Global Education Monitoring Report 2023: Technology in education: A tool on whose terms?*, UNESCO, Paris, 2023. <https://unesdoc.unesco.org/ark:/48223/pf0000385723>.
 27. D2L, D2L introduces the all-new Creator+ with H5P to transform learning experiences, D2L Newsroom, 2024. <https://www.d2l.com/newsroom/d2l-introduces-the-all-new-creator-with-h5p-to-transform-learning-experiences/>.
 28. D2L Brightspace Community, *Use H5P interactives: Smart Import*, D2L Brightspace Community, 2026. <https://community.d2l.com/brightspace/kb/articles/27610-use-h5p-interactives>.