An Exploratory Study on the Role of Generative AI in Designing Educational Board Games

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Abstract: The educational landscape is transforming due to new skill demands, fragmented attention spans, evolving communication patterns, and increased information access. Game-based learning (GBL) has emerged as a potential solution, fostering subject competency and broader skills. However, integrating games into education faces challenges for educators and schools. This study examines Generative AI's (GenAI) role in facilitating board game use in education, based on a case study in an Italian high school implementing a GenAI-enhanced board game for foreign language teaching. Two state-of-the-art GenAI technologies assisted in the whole GBL design process. Findings indicate GenAI can streamline board game integration through flexible rule adaptation, customized artifact production, and rapid content creation, reducing educator workload, as well as extend their capabilities with novel, creative solutions. Benefits are more pronounced when GenAI use is based on an overarching educational strategy. Study's findings have implications for educators and researchers seeking to effectively integrate GBL and GenAI in educational settings.

Keywords: Generative AI in education, Board game design, GBL, Language learning, AI-assisted pedagogy

1. Introduction

The 21st century has ushered in digitally-driven transformations that are altering human communication, cognition, and learning, particularly among young adults accustomed to instant messaging, fragmented attention spans, and ubiquitous access to knowledge (Prensky, 2012). This evolving context necessitates new skills emphasizing adaptability, rapid learning, and multitasking alongside deep subject-specific knowledge.

Game-based learning (GBL) has emerged as a promising approach to address these educational needs (Chou et al, 2023; Gao, 2023; Hanghøj, 2013; Prensky, 2012). Board games, in particular, offer advantages in accessibility and face-to-face interaction compared to digital alternatives (Bayeck, 2020; Gatti Junior et al, 2023; Luckner et al, 2024). However, integrating board games into education faces challenges, including inadequate training, fears of increased workload, rigid curricular requirements, and limited resources for customization (Cantoia et al, 2023; Hanghøj, 2013; York et al, 2022). Furthermore, the physical nature of board games can limit their adaptability compared to digital games. For instance, while a digital game might allow educators to easily switch between different maps or scenarios, a board game with a printed map or fixed components is inherently less flexible, potentially hindering alignment with specific learning objectives or adaptation to diverse educational contexts.

Generative Artificial Intelligence (GenAI) represents a potentially transformative solution, capable of streamlining and enhancing the entire GBL process. However, current literature addresses GenAI and GBL integration fragmentarily, focusing on specific design phases or privileging digital games (Fotaris et al, 2023; Gatti Junior et al, 2023; Tinterri et al, 2024). Research on GenAI applied to GBL, particularly board games, remains scant.

This study investigates how GenAI can be exploited in designing board games to foster GBL, analyzing a single case study of an Italian high school implementing a GenAI-enhanced board game for foreign language teaching. Through Participatory Action Research (PAR), we explore how GenAI can address challenges in integrating GBL and board games into educational practices.

Results indicate that GenAI can automate well-defined game design phases and extend educators' capabilities by suggesting novel ideas and creative solutions, with more evident impact when assisting throughout the entire design process. This study contributes to the dialogue on education's future, offering insights for leveraging GenAI for more effective, engaging, and adaptable learning experiences.

2. Theoretical Background

Game-based learning leverages games to facilitate learning, combining engaging gameplay with educational content (Perrotta et al, 2013; Plass et al, 2015; York et al, 2022). It enhances student engagement, promotes

active learning, and develops skills such as problem-solving and critical thinking. The generative potential of GenAI makes GBL a promising application domain (Gatti Junior et al, 2023; Mollick and Euchner, 2023; Tinterri et al, 2024).

GenAI and Large Language Models (LLMs) represent a transformative shift in AI capabilities, producing human-like outputs across various domains. Their impact extends to software development, content creation, data analysis, and process optimization, poised to transform task approaches and problem-solving across industries.

Emerging literature categorizes GenAI benefits into automation and augmentation (Mollick and Euchner, 2023). Automation optimizes well-defined tasks, improving efficiency, while augmentation expands workers' capabilities, enhancing output quality and creativity. Combined, these dimensions improve operational efficiency and empower workers to achieve higher performance levels.

Research on GenAI and GBL integration has explored various aspects, including assisting educators in game selection and customization (Tinterri et al, 2024), supporting instructional tasks in digital GBL (Yue and Guo, 2023), and theoretically proposing GenAI's potential for augmenting human capacities (Mollick and Euchner, 2023). However, much of the existing literature primarily emphasizes the automation capabilities of AI in educational contexts. This focus may overlook the broader potential of GenAI to augment pedagogical creativity and innovation.

Additionally, while digital games have been a primary focus of GBL research, there remains a significant gap regarding the application of GenAI to board games in educational contexts. Most studies concentrate on online or digital games, leveraging AI potential in code generation (Gozalo-Brizuela and Garrido-Mercha, 2023) and neglecting the unique advantages that board games offer in overcoming infrastructure limitations and facilitating face-to-face interactions (Luckner et al, 2024). This oversight limits our understanding of how board games can be effectively integrated into GBL frameworks.

Furthermore, literature on AI and GBL often addresses the use of AI in education by focusing on specific phases of the game design process. For instance, Hainey et al (2016) ’s systematic literature review highlights various isolated aspects of GBL implementation, while Gozalo-Brizuela and Garrido-Mercha (2023) explored GenAI's application in digital games, primarily analyzing specific design elements. Such an approach may restrict insights into how AI can enhance coherence throughout the entire learning experience. A more integrated perspective is necessary to fully understand the synergies between different design phases and their impact on GBL effectiveness.

3. Methodology

This study employs Participatory Action Research (PAR) to investigate GenAI's role in GBL adoption in education with a focus on board games. PAR enables collaborative knowledge creation between researchers and practitioners, fostering practical solutions to real-world educational challenges (Cornish et al, 2023). This methodology aligns with the study's aim to enhance educational practices through innovative technologies and pedagogical approaches.

The empirical knowledge base derives from a case study at an Italian high school between February and May 2024, focusing on 11 students, aged 18, learning Russian. The GBL endeavor aimed to improve language proficiency and students' ability to integrate knowledge from Russian literature and history courses.

The research utilized two prominent LLMs available at the time of the experimentation: OpenAI's ChatGPT (GPT-4) and Anthropic's Claude (3 Sonnet). The GBL design process was structured according to an adapted version from Nadwa Zulkifli et al (2023), comprising seven phases: Analysis of needs, Learning outcomes definition, Acceptance evidence, Game choice, Game personalization, Impact evaluation, and Instructional strategy.

For each phase, prompts were developed and submitted to both LLMs. Responses were cross-analyzed to identify contributions to the board game design process and highlight limitations. The assessment framework categorized contributions as either automation or augmentation (Mollick and Euchner, 2023). Automation focused on optimizing well-defined tasks, improving efficiency and resource utilization. Augmentation expanded educators' capabilities by providing additional knowledge, perspectives, and creative inputs. The evaluation of GenAI's contribution to board game design was conducted by an experienced educator who had previously implemented GBL in their classes. The educator's expertise allowed for a comparative assessment of GenAI’s impact against traditional GBL implementation methods used in previous years.

The prompt formulation followed an iterative approach, with initial submissions followed by analysis, revision, and resubmission as needed. Different strategies were tested, varying prompt formulation (open versus specific questions) and level of detail provided about students and educator choices throughout the GBL design process. The most effective approach emerged as a process where initial prompts were more general and open-ended, gradually becoming more detailed and analytical as the interaction with the LLMs progressed.

This methodology allowed for a comprehensive exploration of how GenAI can support educators in designing and implementing effective GBL experiences. The PAR approach ensured that the research remained grounded in practical educational needs while leveraging cutting-edge AI technologies to enhance pedagogical practices.

4. Findings

This study examines GenAI's role in designing the GBL process, focusing on teaching Russian in high school. Prompts for each GBL design phase were submitted to two LLMs, with responses analyzed by an experienced educator. The following sections present these prompts and analyze LLMs' outputs, offering insights into GenAI's potential in GBL, particularly for language education. The overall AI-based GBL process is presented in Figure 1. The figure highlights the specific contributions of GenAI and of the educator.

Figure 1: Phases and contributions in board game design

4.1 Design Phases and Prompts

The GBL design process was divided into seven phases, each supported by specific prompts directed at the two LLMs. An introductory prompt (P1) was prepared to provide to the LLMs the setting and the context of the design activity. The prompts of the different phases are highlighted in Table 1, while, in the following paragraphs we describe the rationale for the preparation of the prompts in each phase.

Table 1: Phases and prompts in board game design

P1	You are an experienced language teacher who is working with game-based learning (GBL). Your role is to design GBL lessons following a sequential model composed of the following phases: Analysis of needs (to understand students' characteristics that are relevant in GBL); Learning outcomes (LO) definition (to provide expected Los such as knowledge, skills, and attitudes); Assessment strategy (to identify quantitative and qualitative metrics to assess LO achievement); Game choice (to identify board games matching Los to be utilized); Game personalization (to turn Los into operation in a board game); Impact evaluation (to assess the impact of the activity for the customized game); Instructional strategy (to define the lesson plan for the GBL).
	Phase 1: Analysis of needs
P2	Let's start with the first step, Analysis of needs: Determine students' characteristics and needs. Create 10 questions to collect data on Interest, preference, player type of the students.
P3	Based on your suggestions I have revised the list of questions to collect the data from the students. I delivered the survey and collected responses from students belonging to one class. In the attached file you can find the question in the columns and the answers of the students in the rows. Can you analyze the answers to give suggestions on the creation of the board game for these students?
	Phase 2: Learning outcomes definition
P4	You are a teacher of Russian as a foreign language to this class of students. Students are studying the language, literature and history. However, students see these domains as independent. The overall objective is to help the students integrate the domains of language, literature and history. Students should be capable of positioning the literature authors into the correct historical context, so that the students can better understand and appreciate the authors' work. Outline 10 clear, measurable, and specific Los, in terms of knowledge, skills, and attitudes, that align with the overall objective.
	Phase 3: Assessment strategy
P5	Your aim is to use a board game to pursue the realization of the learning outcomes that you suggested. Now, the first step is to suggest quantitative and qualitative data that can be obtained to assess the Los before, during and after the gameplay.
	Phase 4: Game choice
P6	Suggest 5 off-the-shelf board games from which we can choose the most appropriate ones to pursue the achievements of the Los and the collection of data to assess the achievement of the LOs.
P7	To choose the game for the students, for each of the games that you suggested you need to prepare the following details: game name; game goal; rules; number of players; age rating; duration; game win rules; tools and artifacts; cooperation degree (individual, cooperative, collaborative, cooperative and collaborative); required language level (expected language proficiency of the players); Los (which Los you already suggested are expected to be pursued).
	Phase 5: Game personalization
P8	Based on games characteristics, I choose to play Timeline with the class. You need to change the rules of the game to make it collaborative rather than individual, as the students need to reinforce the collaboration transversal skill. Suggest 3 ways to revise rules to make Timeline a collaborative game.
P9	For Timeline with revised collaborative approach, prepare a description of game rules in Russian language B1 level (CERF classification of language knowledge).
P10	For Timeline with the revised collaborative approach, prepare a list of 20 historical events of Russian history. For each event provide title, date, and short description.
P11	For Timeline with the revised collaborative approach, prepare a list of 20 authors, writers and poets, in Russian literature.
P12*	For Timeline with the revised collaborative approach, and based on the first historical event, prepare one card that can be used in the game.
	Phase 6: Impact evaluation
P13	We will play Timeline with the first option of rules changes. For this, indicate the updated Los and qualitative and quantitative data that can be collected to assess the Los before, during, and after gameplay.
P14	Create a list of 15 questions, qualitative and quantitative, for pre-game phase to assess the following aspects. Quantitative: Pre-game quiz on Russian literary chronology and author-period associations; Self-assessment survey on students' perceived knowledge and collaboration skills. Qualitative: Short written responses on students' understanding of connections between Russian literature, language, and history.

P15	Create a list of 15 questions, qualitative and quantitative, for post-game phase to assess the following aspects. Quantitative: Post-game quiz to measure improvement in chronological understanding; Count of accurate connections made between authors, works, and historical events in a follow-up activity. Qualitative: Reflective essays on what students learned about Russian literary history and the benefits of collaborative learning.
P16	For post-game phase assessment, prepare a self-evaluation form, with 15 questions, which contains a survey on perceived improvement in knowledge and collaboration skills and a peer evaluation on team members' contributions and collaborative skills.
P17	For post-game phase assessment, create a list of 10 questions to be used in a focus group discussion on how the game changed students' perception of the interconnectedness of Russian literature, language, and history.
	Phase 7: Instructional strategy
P18	Based on the game selected, on the rules defined, on the assessment, pre, during, and post-game, create a lesson plan. Consider that one lesson is 50 minutes and the lesson plan can be implemented through more lessons.

* P12 was repeated for all suggested events.

Students' *Analysis of needs.* Two prompts guided data collection (P2) and analysis (P3) for student characterization. LLMs provided comprehensive questions covering game preferences, players' type, competitive spirit, and attitudes. The resulting survey yielded granular insights, informing game design aspects such as complexity and operational considerations. However, the LLMs also suggested collecting data on topics that students might be less equipped to self-evaluate accurately. For instance, ChatGPT proposed investigating students' perceptions of effective learning through games, while Claude suggested analyzing their comfort with making mistakes during the GBL process. While potentially valuable, these suggestions assume a level of metacognitive awareness and experience with GBL that students may not possess. Such assessments typically fall within the purview of experienced educators.

LLMs' suggestions were subsequently implemented in a survey administered to a class of 11 students. The resulting needs analysis was comprehensive and granular, revealing student preferences and informing various aspects of game design, including strategy complexity and operational considerations such as preferred game duration, frequency of play, and methods for rule clarification.

Two notable insights emerged from the LLMs' analysis. First, it was recommended to integrate both individual and collaborative elements into the game design. This approach aims to leverage students' existing preferences while simultaneously fostering the development of transversal competencies. Second, LLMs suggested implementing a progressive difficulty scale, which is a peculiarity of games, to enhance participant engagement.

Learning outcomes definition. A single prompt (P4) elicited suggestions for learning outcomes aligned with students' characteristics and educational objectives. The prompt was intentionally crafted to be both context-specific and open-ended. While the educator outlined the educational setting (a Russian as a foreign language class) and the multidisciplinary nature of the GBL (encompassing language, literature, and history), the request to LLMs was to identify an extended number of learning outcomes. This approach aimed to allow for a wide range of potential outcomes and to stimulate the LLMs to generate diverse and creative suggestions. The intentionally open-ended prompt resulted in a diverse set of outcomes spanning language proficiency, historical contextualization, critical thinking, and cultural awareness.

The LLMs demonstrated a nuanced understanding of the interdisciplinary nature of the task. They offered outcomes that connected the domains of language, literature, and history. With a diverse set of well-articulated outcomes, the LLMs enhanced the educator's ability to design a comprehensive and integrated learning experience. The range of suggestions provided flexibility in selecting the most suitable outcomes for the specific needs and abilities of the student group while aligning with the overall educational goals.

Assessment strategy. One prompt (P5) focused on identifying qualitative and quantitative data for outcome assessment. LLMs suggested methods such as pre- and post-game tests, observational assessments, and reflective journaling, along with operational guidance on data collection. The breadth of suggestions highlights the LLMs' potential to enhance educators' capabilities in designing evaluation strategies. However, the final selection and implementation depend on the educator's professional judgment to tailor methods to specific learning outcomes, student characteristics, and practical constraints.

Game choice. Two prompts (P6, P7) guided the selection of an appropriate off-the-shelf board game. LLMs provided game suggestions with detailed descriptions, including information about game mechanics and educational potential, as well as practical suggestions for implementation. Both responses were analytical overviews that closely matched the prompt requirements. The responses provided enough detail to help the educator make an informed decision. Importantly, some suggested games were unfamiliar to the educator, demonstrating that the LLMs could broaden their knowledge and expand their options.

Game personalization was implemented through five prompts (P8-P12), demonstrating a progressive refinement of the game design process with increasing educator involvement. P8 asked for the adaptation of the Timeline game to a collaborative format, reflecting the educator's unique knowledge of the class needs, particularly the importance of fostering collaborative skills—information not available to the LLMs. Both LLMs provided focused and creative responses, demonstrating their ability to adapt game mechanics to specific educational requirements. P9 requested game rules in Russian at a B1 language level, emphasizing the production of specific game artifacts. While both LLMs provided effective responses in Russian, analysis using Textometer (Dmitrieva, 2023; Laposhina et al, 2018) showed that ChatGPT's output was at a B2 level, indicating some inconsistency in adhering to the language level. P10 and P11 focused on generating additional game materials, specifically historical events and literary authors. Although the LLMs provided correct responses, this stage emphasized the crucial role of the educator in aligning content with the school curriculum—a context beyond the LLMs' knowledge. P12 asked for the production of card materials based on the educator's selections. This prompt revealed differences in LLM capabilities: ChatGPT generated images, while Claude provided extended descriptive text. For example, for the "Baptism of Russia" event, ChatGPT produced an effective image, while Claude offered a comprehensive historical and cultural context. This complementarity in LLM functionalities proved valuable for creating rich educational materials. However, the image generation also exposed potential biases in LLM training data, as seen in an anachronistic depiction of the 1957 Sputnik satellite. This phase highlighted the complementary strengths of different LLMs In game modification and material creation while also revealing challenges in language level consistency and potential biases in generated content.

Impact evaluation. Five prompts (P13-P17) addressed various aspects of evaluating the game-based training activity, focusing on the specific personalized game. LLMs identified updated learning outcomes specific to the adapted collaborative game and determined appropriate data collection methods (response to P13). They provided specific and operational contributions, detailing not just what to assess but also how to collect the data. Notably, Claude emphasized the interdisciplinary connections between language, literature, and history, aligning closely with the educator's original objectives. LLMs proposed precise, analytical, and operational questions for pre- and post-gameplay assessment of the students (response to P14 and P15). In suggesting self-evaluation questions (P16), LLMs also proposed cross-evaluation methods, such as having students assess their teammates' collaborative spirit and leadership qualities, adding a valuable peer assessment dimension to the evaluation process. In the identification of questions for a post-gameplay focus group (response to P17), LLM' suggestions extended beyond assessing knowledge gains, incorporating questions about how the game experience altered students' perspectives on the subject matter. This approach offered the educator an opportunity to explore deeper, more transformative learning outcomes. Throughout this phase, the LLMs demonstrated their capacity to augment the educator's evaluation strategies, providing a rich array of assessment tools and perspectives.

Instructional strategy. The final phase focused on the definition of a specific lesson plan (P18). This phase integrated the collaborative-oriented rules, specific learning outcomes, and assessment approaches developed in earlier stages. The responses provided by the LLMs demonstrated a high level of effectiveness in capturing and synthesizing the educator's requirements. Furthermore, the lesson plans incorporated key suggestions from earlier phases, such as providing the educator with elements on how to implement a progressive difficulty curve to enhance student engagement. This showcased LLMs' ability to maintain consistency and coherence throughout the design process.

LLMs demonstrated their potential to both optimize and extend the educators' capabilities, streamlining activities, offering diverse perspectives, creative solutions, and detailed operational guidance. However, the interplay with the LLMs unveiled the limitations of the technology and underscored the crucial role of educators in guiding the design process, ensuring curriculum alignment, and critically evaluating LLM outputs.

4.2 Analysis of the LLM contribution to GBL design

The integration of LLM in GBL design demonstrated significant impacts in terms of both automation and augmentation. Automation benefits primarily manifested as increased efficiency, reduced workload for educators, and streamlined processes. These included rapid generation of assessment tools, swift creation of lesson plans, and efficient production of game materials. Augmentation benefits expanded educators' capabilities by providing novel ideas, diverse perspectives, and creative solutions. This included suggesting innovative game adaptations, offering interdisciplinary learning outcomes, and introducing educators to new game options. The synergy between these two aspects of LLM contribution proved particularly valuable in enhancing the overall design process. Table 2 presents a detailed breakdown of the LLMs' contributions across the seven phases of the game design process and the role of the educator.

Table 2: Benefits and limitations of GenAI in the board game design process

Design phases	Automation benefits	Augmentation benefits	Educator's role
1. Analysis of Needs	Rapid generation of student assessment questions	Comprehensive perspective on student characteristics to consider	Selection and adaptation of questions based on specific class context
2. Learning outcomes definition	Quick generation of diverse learning objectives	Creative suggestions for interdisciplinary outcomes	Refinement and alignment with curriculum standards
3. Assessment strategy	Efficient creation of assessment metrics	Innovative ideas for qualitative and quantitative measures	Selection and customization of assessment methods
4. Game choice	Rapid suggestion of multiple game options	Introduction to new, potentially unknown games	Final selection based on class needs and resources
5. Game personalization	Swift generation of game adaptations and materials	Creative ideas for game modifications and new content	Guiding the personalization process with class-specific insights
6. Impact evaluation	Quick development of diverse evaluation tools	Suggestions for multi-faceted assessment approaches	Tailoring evaluation methods to class objectives and student needs
7. Instructional strategy	Rapid creation of lesson plan templates	Innovative ideas for integrating the game into broader curriculum	Adapting and finalizing the instructional approach

In the needs' analysis, LLMs demonstrated strong automation capabilities by quickly generating comprehensive sets of student assessment questions, significantly reducing the time educators needed to develop these tools. The LLMs provided a wide range of questions covering various aspects of student characteristics, including language proficiency, learning preferences, and prior knowledge of Russian literature and history. The augmentation aspect was also present, as LLMs offered diverse perspectives on student characteristics, potentially broadening the educator's view.

The Learning outcomes definition phase shifted towards augmentation, with LLMs providing creative and interdisciplinary learning objectives. This expanded the educator's perspective and facilitated a more holistic approach to language learning integrated with literature and history. The LLMs suggested outcomes that addressed not only language proficiency but also cultural understanding, critical thinking, and historical context analysis.

For the Assessment strategy, LLMs efficiently automated the creation of assessment metrics while also augmenting the process with innovative ideas for both qualitative and quantitative measures. LLMs proposed a mix of traditional language assessments, creative writing tasks, and collaborative projects, as well as peer evaluation methods and reflective journaling.

The Game choice phase strongly emphasized augmentation, as LLMs introduced educators to potentially unknown games and offered creative suggestions for game selection. This significantly expanded the educator's repertoire of educational game options. The LLMs provided detailed descriptions of various board games and offered insights into how each game could be modified to incorporate elements of Russian literature and history.

In Game personalization, LLMs exhibited strong augmentation capabilities by providing creative ideas for game modifications and generating new content. This phase also saw automation benefits in the swift production of adapted game materials. The LLMs suggested innovative ways to incorporate Russian literary quotes, historical events, and cultural references into the game mechanics and rapidly generated custom card content, game board designs, and rule modifications.

The Impact evaluation phase balanced automation and augmentation, with LLMs quickly developing diverse evaluation tools while also suggesting multi-faceted assessment approaches. The LLMs proposed a combination of pre- and post-game assessments, in-game performance metrics, and reflective exercises to comprehensively evaluate students' progress.

Finally, the Instructional strategy phase leaned more towards automation, with LLMs rapidly creating lesson plan templates, though still offering some augmentation through innovative ideas for curriculum integration. LLMs provided detailed lesson structures and suggested ways to connect GBL experience with regular classroom activities and homework. The analysis revealed a pattern where automation benefits were more pronounced in the initial and final phases of the design process, while augmentation dominated the middle phases, where creative input and novel ideas were most valuable.

The application of LLMs across the entire design process generated benefits that transcended the contributions to individual phases. This holistic approach created a synergy between different stages of the design, enhancing the overall coherence and effectiveness of the GBL experience. For instance, the evaluation strategies developed in the final phase were directly informed by and aligned with the acceptance evidence designed at the beginning of the process. Similarly, the lesson plan design incorporated suggestions for progressive difficulty that emerged during the initial needs analysis phase.

Throughout this process, the educator's role remained crucial. While LLMs provided valuable suggestions and efficient tools, the educator was responsible for critical decision-making, contextualizing LLM’s outputs to the specific classroom environment, and ensuring alignment with curriculum standards and pedagogical goals. The educator's expertise was particularly vital in selecting appropriate assessment questions, refining learning outcomes, choosing suitable games, guiding personalization, and adapting evaluation methods and instructional strategies to meet the students’ unique needs.

This synergy between LLM’s capabilities and educator expertise demonstrates the AI potential to enhance the GBL design process while underscoring the irreplaceable role of human judgment and pedagogical experience in effective educational design. The complementary nature of AI assistance and human expertise resulted in a richer, more innovative, and more tailored educational experience than either could have achieved alone.

5. Discussion and Conclusion

This study explored GenAI's role in GBL, focusing on integrating language, literature, and history in Russian language learning and demonstrated AI’s potential to automate and augment the design process. The findings contribute to existing literature on AI in education in several ways.

First, while much extant literature focuses on AI's automation capabilities (Tinterri et al, 2024), our research highlights the substantial augmentation potential of GenAI. This shift addresses a limitation in the literature that often overlooks how AI can enhance pedagogical creativity and innovation. Our results show that AI can not only streamline routine tasks but also extend educators' capabilities by providing novel ideas, diverse perspectives, and creative solutions. This augmentation was particularly evident in the middle phases of the game design process, expanding our understanding of AI's role in education beyond efficiency gains to a tool for promoting educational creativity and innovation.

Second, this study contributes by focusing on the application of AI in educational board game design, in contrast to existing literature primarily addressing online or digital games. This focus is particularly relevant given board games' accessibility in various educational settings, including those with limited technological infrastructure. By demonstrating how AI can support board game design and adaptation, this study opens new possibilities for implementing GBL without extensive digital resources.

Third, our research adopts a holistic approach to AI-assisted GBL, examining AI application across the entire GBL development spectrum. This integrated perspective responds to the fragmented approach observed in existing literature, which often analyzes AI role within isolated phases of the game design process. By revealing synergies between different phases, we provide a more comprehensive understanding of how AI can enhance

coherence and effectiveness throughout the entire GBL experience. Furthermore, the study unveils the complementarity and the added value created through the integration of different AI technologies.

The observed pattern of AI's contributions suggests a strategic approach to AI integration. Educators and instructional designers can leverage AI's efficiency-enhancing capabilities in the planning and implementation stages while embracing its creative potential during the core design phases.

The study underscores the critical role of human expertise in the AI-assisted design process. While AI provided valuable suggestions and efficient tools, the educator's judgment remained crucial in contextualizing AI outputs, ensuring curriculum alignment, and tailoring the game to specific student needs. This finding contributes to the ongoing discourse on human-AI collaboration in education, emphasizing the complementary nature of AI capabilities and human pedagogical expertise.

Despite these contributions, the study shows limitations that represent opportunities for future research. The focus on a single case study in foreign language teaching limits generalizability to other educational contexts. This localized setting may not reflect the diverse challenges and dynamics present in different regions or educational systems. The study concentrated on language teaching, specifically examining aspects such as communicative competence and capacity to link foreign language proficiency, literature, and history. These specificities may not translate directly to other subjects or educational levels. Future research should extend this approach to diverse educational contexts and larger sample sizes to better understand the broader applicability of GenAI in GBL design process.

Furthermore, the study investigated the role of AI in GBL within a limited timeframe. Future studies could adopt a longitudinal approach and explore long-term impacts of AI-designed games on student learning outcomes, motivation, and engagement. Additionally, the complementary strengths of various LLMs demonstrate potential synergies in combining multiple AI tools, opening an avenue for future research.

Finally, research into educators' professional development needs to effectively leverage AI in game design would be valuable. Investigating ethical implications of AI use in educational design, including data privacy, algorithmic bias, and the changing role of educators, represents another area for future inquiry.

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