

Building Bridges: A Collaborative Pipeline for Educational Game Creation

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Abstract: This paper introduces a collaborative participatory design pipeline that connects subject-matter experts (SMEs), game designers, students, and educators to co-create classroom-feasible educational games. We demonstrate this process through DIETER (Digital EduCAtional Escape Room), a modular Educational Escape Room (EER) composed of short, tablet-ready mini-games designed to foster STEM competencies in upper secondary education. These types of games are particularly well-suited because students have to work together, learning becomes interactive, and they connect academic concepts with practical challenges. We began by collecting data on students' gaming behaviour and hardware preferences to provide a basis for realistic design decisions for school contexts. In parallel, a group of SMEs (lecturers at the University of Applied Sciences Technikum Wien) identified STEM topics suitable for game-based learning and, in co-design workshops, translated priority topics into actionable mini-game concepts including constraints and learning outcomes. These design prompts were then handed to game design students in the bachelor's program in computer science as authentic briefs across two courses, encouraging creativity while maintaining curricular alignment. The students carried out the game design and production process and iterated prototypes under real-world constraints. As part of the participatory process, we also conducted a full-day workshop with our partner school (Hertha Firnberg Schools for Business and Tourism, upper secondary level). During this session, students were introduced to the basics of game development and engaged in creative ideation activities such as brainstorming and the collective notebook method. These activities generated additional mini-game ideas and provided deeper insights into students' interests, expectations, and play preferences, helping to design age-appropriate and engaging educational game concepts. To validate classroom practicality and pedagogical usefulness, we conducted validation workshops with lecturers at the University of Applied Sciences Technikum Wien. In these sessions, participants playtested the resulting prototypes and collaboratively refined gameplay, scaffolding, and reflection prompts — focusing on feasibility (time, setup, group work), fit with lesson phases, and the requirements for meaningful reflection and knowledge transfer.

Keywords: Educational escape room, Participatory design, STEM education, Iterative game design, Focus groups, Project based learning

1. DIETER

We demonstrate this pipeline through DIETER, a system that situates short, focused STEM tasks as mini-games in the narrative of a research station. Each mini-game targets specific competencies, ships as a standalone module. These mini-games ship as independent APKs (Android Packages) integrated via a small set of standardized interfaces (launch, exit, scoring, time) to interact with the research station. This decoupling enables decentralized development and rapid iteration without frequent core updates. Nicholson identifies three basic ways, as shown in Figure 1, in which puzzles can be organized in an escape room. (Nicholson, 2015) Due to the decentralized development and to avoid dependencies, the Dieter Project uses the “open” structure, in which all rooms can be played in any order.

Designing educational games that are both pedagogically meaningful and feasible for classroom use remains a persistent challenge. Time-constrained lessons, heterogeneous devices, IT policies, and the need for explicit learning outcomes often collide with the creative and technical demands of game production. (Arnab *et al.*, 2015)

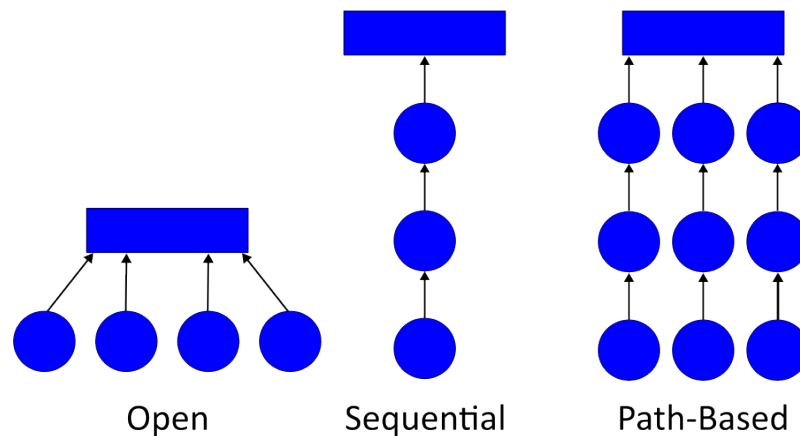


Figure 1: Basic Forms of Puzzle Organization (adapted from Nicholson, 2015)

2. Target Group Analysis

We conducted an exploratory survey to ground DIETER’s design in Austrian upper secondary classrooms ($n = 77$). The sample reflects the target group (mainly 6th/8th class; 82% in years 2 and 4), with a gender split of 61% female, 36% male, and 2% other/prefer not to say. On a 1–5 scale (1 = “play very gladly,” 5 = “do not like playing on it”), smartphones were rated most positively (mean 2.10), followed by laptops (2.58); tablets were less favored for leisure gaming (3.73; 44% chose “5”). “Special hardware” typical of classrooms (e.g., interactive whiteboards) was strongly disliked (mean 4.56; 75% “5”). Two implications follow: avoid novelty/infrastructure-heavy devices and keep interaction touch-first, low-threshold. Although smartphones were most liked, DIETER prioritizes tablets for classroom use to retain familiar touch while improving readability and shared teamwork (e.g., viewing diagrams or multi-step instructions together). Thus, the survey supports “mobile-like” interaction and discourages reliance on whiteboards/AR/VR; tablets are a practical compromise under school constraints. Complementary availability data reinforce this choice: the JIM 2025 study (mpfs, 2025) reports tablets in 87% of households of 12–19-year-olds in Germany, suggesting broad access in the DACH context. This tablet-first, low-threshold approach is consistent with the Federal Ministry’s 8-Point Plan, which calls for competence-oriented, practicable integration of digital media in everyday teaching (Federal Ministry Education Republic of Austria, 2020).

3. The Pipeline

The DIETER pipeline translates disciplinary ideas into classroom-feasible mini-games. The overarching goal is to enable decentralized creativity while maintaining pedagogical rigor, technical robustness, and practical feasibility for upper secondary classrooms.

Organizationally, the pipeline follows a lean, sprint-based cadence with defined review gates (Cober et al., 2015; Tobar-Muñoz, Baldiris and Fabregat, 2023), as shown in Figure 2. An initial co-design phase with SMEs produces Brief v1, which undergoes a didactic review for clarity of learning outcomes and assessment hooks (Arnab et al., 2015). Game Design Students then produce a prototype (from greybox to clickable). In the last phase the content accuracy is checked by SMEs, for scaffolding coherence by the didactics team, and for basic technical stability. Validation workshops with teachers and lecturers focus on feasibility—time, setup, group work—and on UI/UX adjustments, leading to targeted revisions of gameplay, hint progression, and teacher materials (An et al., 2016; Veldkamp et al., 2020).

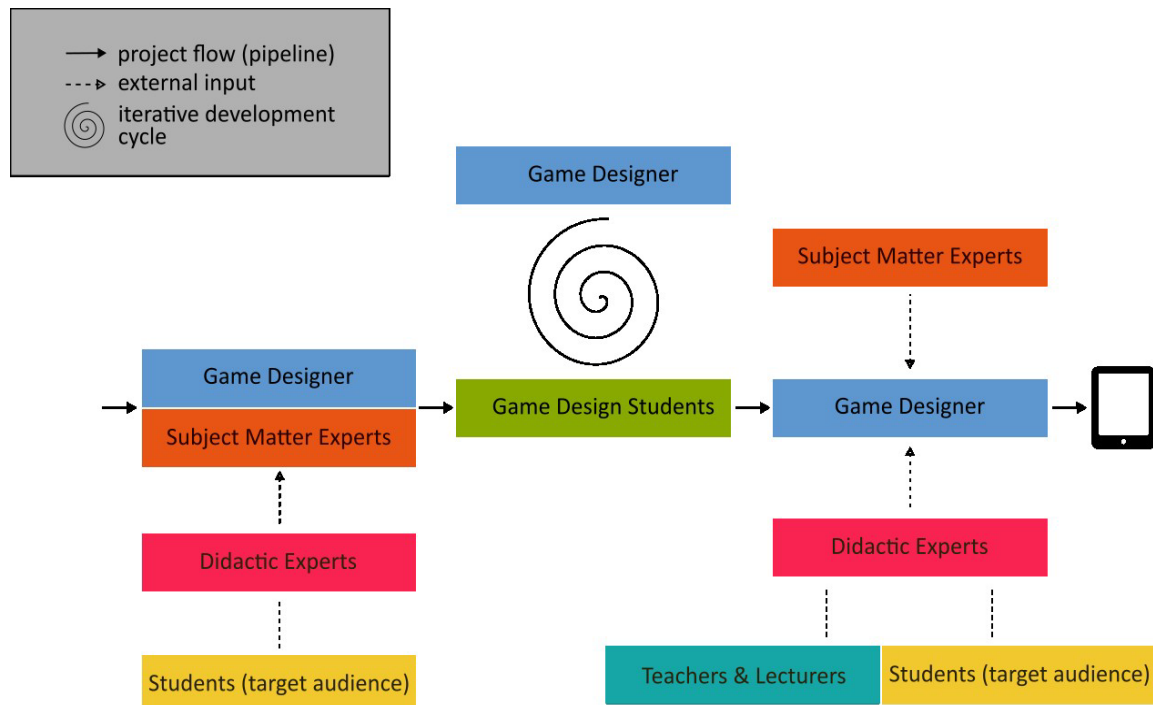


Figure 2: An illustration of the Dieter pipeline, which can be divided into three phases (requirements, development, testing/validation)

3.1 Requirements

Subject-matter experts (SMEs) and game designers provide the disciplinary starting point. In facilitated group workshops, they identify STEM concepts that lend themselves to short, problem-oriented game tasks and articulate these as actionable concepts. The outcome is a set of structured briefs with explicit learning outcomes (Panke, 2019). These workshops also produced game concepts that were provided to students as Game Design Documents. Ideas developed in collective notebooks were passed on in that format as well. In addition, a stimulus word list and a morphological box (Zwicky box) were prepared to spark creativity. The didactics team serves as a bridge between game design and teaching practice. It ensures that the emerging game concepts are appropriate for the target audience and can be meaningfully situated within typical lesson phases. Concretely, the team develops a staged hint and scaffolding logic, formulates reflection prompts that support knowledge transfer beyond the game session, and produces concise implementation guides for educators. These guides summarize setup requirements, time budgets, group sizes, role models for collaboration. In parallel, the didactics team aligns learning outcomes with observable indicators, short assessment items, and transfer tasks (Fotaris and Mastoras, 2022) so that the games do not merely engage but also yield demonstrable learning.

3.2 Development

Mini-game development is further supported through integration into university courses (e.g., Innovation Labs and Game Development), where small groups of students as well as individual participants contributed to the design and implementation of game concepts under the supervision of a game designer. They translate briefs into playable prototypes and iterate them under real-world constraints of time, devices, and deployment models. This approach exemplifies key principles of project-based learning (PBL), particularly by providing students with purposeful, authentic experiences and ensuring deep integration with course content. (Lucas Education Research, 2021)

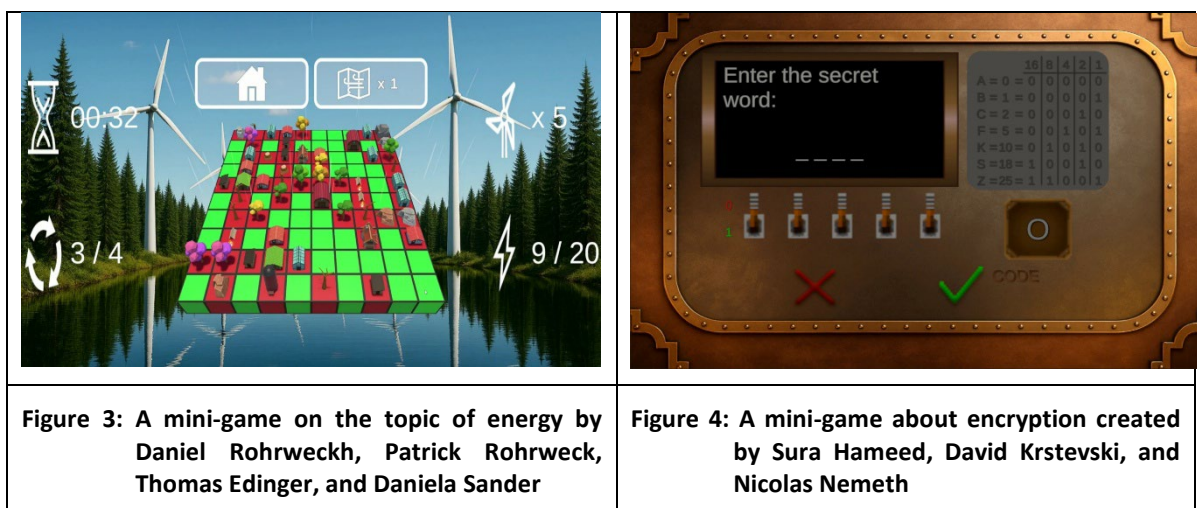


Figure 3: A mini-game on the topic of energy by Daniel Rohrweckh, Patrick Rohrweck, Thomas Edinger, and Daniela Sander

Figure 4: A mini-game about encryption created by Sura Hameed, David Krstevski, and Nicolas Nemeth

3.3 Testing and Validation

Teachers at the partner school and lecturers at the university bring a practice-oriented view of feasibility and didactic embedding. In validation workshops, they playtest prototypes, discuss alignment with lesson and course formats, and articulate requirements for assessment and classroom management. A dedicated workshop with the focus group Mathematics and Computer Science explored the integration of serious games into higher education teaching using DIETER's mini-games as concrete anchors. The resulting feedback is highly actionable: it addresses setup time and device readiness, suitable group sizes, likely bottlenecks in classroom orchestration (Jääskä and Aaltonen, 2022), and the kinds of reflection activities that make learning visible. These insights feed directly into revisions of gameplay, scaffolding, and teacher-facing materials.

4. Conclusion and Future Work

The idea-generation process proved more time-consuming than expected. Finalized prototypes showed a strong bias toward replicating existing educational games, especially quiz formats. From a pedagogical perspective, this matters because learning content should be intrinsically integrated into the core gameplay rather than added as an external layer (Arnab *et al.*, 2015). To counter this, the current cohort explicitly banned recurring concepts from the previous year, aiming to nudge out-of-the-box thinking. Future work should systematically test how our interventions affect originality and feasibility.

While players were generally able to interact with the games without instruction, they did not always recognize the underlying concepts as learning content. This highlights the need for explicit debriefing to connect gameplay with the intended learning outcomes. These findings point to the centrality of post-game reflection: differences in prior knowledge require scaffolding during play, and the recognition of learning content often requires explicit framing after play (Sanchez and Plumettaz-Sieber, 2019). With direct implications for classroom practice, this points to the need for supporting materials that help teachers frame and contextualise the content for their classroom. Especially the curriculum alignment is a key factor in teachers' technology adoption (Kebritchi, 2010).

Ethics Declaration: Data collection was restricted to anonymized surveys and workshops focusing on gaming habits and usability. No sensitive personal information was gathered, participation was entirely voluntary, and no interventions beyond standard educational activities took place.

AI Declaration: We used AI tools to support writing and organization. Specifically:

- ChatGPT (OpenAI) was used for phrasing suggestions, concision edits, transitions, and selected translations (German–English).
- NotebookLM (Google) was used to analyze and organize notes and sources.

All AI outputs were treated as drafts. The authors reviewed, verified, and edited all text; checked all citations, data, and claims against primary sources; and are solely responsible for the final content.

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