(RIPPA) Escape to Learn: Exploring Non-linear Puzzle-Based Learning in Computing Education

Salma ElSayed
s.elsayed@abertay.ac.uk
Abertay University
Dundee, Scotland, UK

Marwan Qaid Mohammed
m.mohammed@abertay.ac.uk
Abertay University
Dundee, Scotland, UK

Abstract

Escape room-inspired activities are increasingly used in education for their immersive, engaging nature. However, most implementations are linear and centrally controlled, limiting pedagogical depth. Physical escape rooms offer richer experiences but are costly and impractical at scale. This RIPPA explores a scalable alternative: non-linear, digital or hybrid escape room designs embedded within teaching materials. Addressing student disengagement in higher education, the project investigates whether playful, puzzle-based formats can improve engagement, enjoyment, and understanding. Focusing on Artificial Intelligence (AI) and Machine Learning (ML) education, the activity builds on an initial implementation to bring educators together to co-develop, trial, and evaluate this approach. The group will share experiences, analyse data, and produce outputs to assess its pedagogical value. The findings may extend to wider computing education.

CCS Concepts

• **Social and professional topics → Computing education**; • **Human-centered computing → Collaborative and social computing**.

Keywords

Computing Education, Active Learning, Puzzle-based Learning, Escape Room Pedagogy

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1 Introduction

Student engagement in higher education remains a concern, especially in technically demanding subjects such as AI and ML. Traditional delivery methods often fail to maintain interest or foster deep understanding [7]. Abstract concepts such as gradient descent or neural network architectures often benefit from hands-on exploratory approaches. Students are inclined to favour practical classes and often neglect lectures or reading. This leads to knowledge gaps and a notable disconnect between foundational understanding and implementation. Educators have increasingly turned to active and playful learning strategies to boost motivation and engagement. Escape room-inspired learning has become increasingly popular in higher education, offering playful, immersive, and collaborative learning experiences with the teaching material through puzzle-based learning and narrative-driven tasks [6, 8].

Puzzle-based learning complements the nature of AI/ML workflows, offering a bridge between theory and practice [5]. Moreover, the narrative exploratory nature of escape room-inspired activities lends itself well to tasks in computing and data science [3]. Based on extensive engagement with workshops, the lead has seen strong enthusiasm for this approach from national and international educators. However, most implementations of educational escape rooms remain linear and static, guiding students through fixed sequences via a single platform. Such decontextualised delivery [9] does not reflect the dynamic structure of escape rooms, and most importantly, the authenticity of true everyday non-linear learning paradigms [1, 10]. While physical escape rooms offer richer, non-linear exploration and greater authenticity, they are costly, resource-intensive, and logistically impractical in many HE settings. The field also lacks subject-specific research and effort in the education community are fragmented across several groups and initiatives, with little coordination or shared infrastructure.

To address these gaps, we propose a shift to a non-linear puzzle-based designs embedded across the learning materials, allowing students to encounter and solve escape challenges organically as they engage with the curriculum. We trialled this in our ML teaching by embedding escape clues in different materail including lectures, programming exercises, and quizzes, rather than a single site. Initial observations suggest increased curiosity, repeated engagement, and better conceptual linkage, but further evidence is needed.

This RIPPA proposes a collaborative study via UKICER to investigate how digitally delivered or hybrid, non-linear escape room-inspired pedagogy can foster authentic learning and improve outcomes in computer science education to measure knowledge gains [2, 4]. It will build a network of educators to co-design, test, and evaluate puzzle-based learning activities, with AI/ML as the focus, but with potential applicability across other computing domains.

RQ1: To what extent does the integration of non-linear, puzzle-based activities in AI/ML teaching impact student engagement? (as evident through self-reported engagement scales and instructor observations)

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RQ2: Does participation in non-linear, puzzle-based activities lead to measurable improvements in students' conceptual understanding of AI/ML topics? (as evidenced by pre- and post-activity assessments)

RQ3: What specific barriers and facilitators do educators report when implementing non-linear, puzzle-based learning activities in AI/ML curricula? (based on post-implementation reflections and structured interviews) Sub-question: How do institutional resources and constraints influence implementation?

2 Goals and Outcomes

- Trial non-linear escape room learning activities in AI/ML modules or similar technical contexts.
- Evaluate the impact of this pedagogy on student engagement, understanding, and experience.
- Identify design and delivery challenges and share effective strategies.
- Develop common instruments and frameworks for future studies.
- Gather student input on puzzle design to improve accessibility and engagement.
- Co-author a journal paper to disseminate findings and recommendations, alongside an open-access toolkit for non-linear escape room design in AI/ML.
- Establish a working group or mailing list focused on interactive and game-inspired learning in Computer Science to sustain collaboration beyond the RIPPA.

3 Methodology

Collaborators will attend a start-up workshop at UKICER to share ideas, define a shared scope, and co-design activities suited to their own teaching contexts. They will be asked to collaboratively plan their interventions, aligning on target concepts, student levels, and formats (e.g. formative activity, assessment component, in-class game).

A shared ethical framework will be discussed, with each institution responsible for local ethical approvals. Additionally, a common questionnaire will be co-designed to collect student perceptions on engagement, learning, and experience, allowing cross-site comparison. For thematic coding, a template for educator reflections will be developed to gather qualitative data on implementation and design insights. Collaborators will decide to which subject/topic/stage they will apply the study.

Collaborators will pilot-test activities on a small scale to the RIPPA group before full implementation to refine puzzles and instruments. Once their designs are finalised, they will implement the activity during a teaching period of their choice. This could be on a scale of the full semester or a subset of the topics. Collaborators will distribute the survey instruments as planned. Data to be collected include pre- and post-activity concept checks (where feasible), student questionnaires, student performance metrics (if aligned with assessment), and educator reflection logs or interviews.

The collected data will be shared and centralised and the collaborators will contribute to the data analysis by performing descriptive statistics and paired statistical tests for concept checks, thematic analysis for open-ended questionnaire and reflection responses, and correlational analysis to explore links between perceived engagement and understanding. Finally, they contribute to writing the publication and/or developing outputs (e.g. toolkit, repo).

4 Plan

Due to the timing of the UKICER conference in September 2025, and the concurrent start of Semester 1 in most UK institutions, it will not be feasible to implement activities immediately. Therefore, practical implementation is planned for Semester 2, 2026, allowing adequate time for preparation and integration into teaching schedules.
4th Sep 2025: UKICER start-up workshop, present plan, brainstorm.
Sep: planning of activities. remote collaboration and support.
Early Oct: online meeting 1, follow-up, survey instruments, ethics.
Oct: design puzzle-based activities, remote support.
Early Nov: online meeting 2, follow-up, pilot test, troubleshoot.
Dec: online meeting 3. wrap up.
Jan-Apr 2026: implementation and data collection, remote support, drop-in meetings.
May-June: online meeting 4, data analysis.
June-Aug: final analysis and writing.

5 Intended Takeaways for Collaborators

- Practical experience designing and evaluating puzzle-based learning in technical subjects
- Strengthened skills in research design, data collection, and educational evaluation
- Connections with like-minded educators for future collaboration
- Access to shared tools, examples, and insights to support future adoption
- Opportunities to inform institutional strategies for active learning in technical subjects
- Pathways to identify and develop grant opportunities to support follow-up studies informed by the findings

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