**Research Protocol: Escape to Learn — Exploring Non-linear Puzzle-Based Learning in Computing Education**

1. **Introduction and Background**
   1. **Rationale**

Student engagement and deep conceptual understanding remain challenging in technically demanding subjects like Artificial Intelligence (AI) and Machine Learning (ML). Traditional teaching methods often fail to maintain interest or connect theory to practice effectively. Inspired by escape room pedagogy, this project explores non-linear, puzzle-based learning as a playful and immersive approach to enhance engagement and learning outcomes. There is a gap in scalable, flexible, and subject-specific implementations of such pedagogies, especially integrating gamification alongside traditional methods. This study aims to fill that gap by developing and evaluating unified learning resources embedded with puzzle-based activities across AI/ML curricula.

* 1. **Research Questions**

1. RQ1: How does the integration of non-linear, puzzle-based activities in AI/ML education affect student engagement?
2. RQ2: Does participation in these activities improve students’ conceptual understanding of AI/ML topics?
3. RQ3: What barriers and facilitators do educators encounter when implementing this pedagogy, and how do institutional contexts influence delivery?
4. **Workshop and project activity timeline draft**

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| **Timeline** | **event / actor** | **activity** | **outcome** |
| **4th Sept 2025** | **start-up workshop (in-person)**  project leads | present {rationale and aims, pedagogic theory, examples, RiPPA plan}  brainstorm potential interventions: study design, ethical considerations, target concepts, student levels, solo vs group, formats (e.g. formative, summative, in-class) etc. | awareness of project scope  initial ideas for interventions  ethical framework (rough)  sign-ups |
| participants  (1.15 hrs) |
| **Sep 2025** | **follow-up (remote)**  **project leads** | share collaborative repository  host example resources and literature  invite remote collaboration on survey instruments and educator reflection templates | shared access to tools and ideas  support flexible, context-sensitive adaptations |
| **project leads + participants** | begin planning and designing their own puzzle-based activity | early-stage activity plans tailored to local context |
| **early Oct 2025** | **online group meeting 1**  (1.5–2 hours) | peer pilot-testing in breakout rooms  finalise student questionnaire  finalise educator reflection log  ethics status updates | refined teaching activities plans  co-designed data collection instruments  peer feedback loop |
| **follow-up (project leads)** | share finalised survey instruments  confirm shared data collection procedures | ready-to-use materials for participants |
| **Oct 2025** | **all participants** | design puzzle-based activities  remote collaboration and support  ethics updates | almost ready-to-use activities for students |
| **Early Nov 2025** | **online group meeting 2**  (1.5–2 hours) | report on ethics approval  final troubleshooting before deployment | refined activities and deployment plan  final update of local ethics approval |
| **Dec** | **online group meeting 3 (drop-in)**  (1.5–2 hours) | Follow up  wrap up the term | finalised activities and deployment plan  clear timeline for implementation  final thoughts |
| **Feb – April 2026** | **all participants** | implement escape room/puzzle-based activities  collect student perception data, concept checks (if feasible), performance data (if linked to assessment)  log reflections and challenges | local implementations documented  data collection aligned to shared framework |
| **May-June 2026** | **online group meeting 4**  (1.5–2 hours) | debrief session  share initial data insights  discuss publication pathways and authorship | collaborative planning for outputs |
| **follow-up (project leads)** | collate, clean, and centralise data  maintain shared data repository | dataset for cross-site analysis |
| **June – Aug 2026** | **project leads + collaborators** | draft collaborative paper/toolkit  iterate on drafts via shared overleaf | final output ready for dissemination (e.g. journal article, toolkit) |

1. **Study Design and Methodology**
   1. **Study Design**

This is a mixed-methods, multi-institutional collaborative study involving the co-design, pilot testing, and evaluation of non-linear, puzzle-based learning activities embedded in AI/ML curricula. Both quantitative (pre/post assessments, surveys) and qualitative (educator reflections, student feedback) data will be collected.

* 1. **Participants**

The target population includes AI/ML students and educators across participating institutions in Great Britain. Participants will be selected from course cohorts delivering the standardized six-lecture curriculum developed for this project. Sampling will aim to balance representation across regions (England, Scotland, Wales, Ireland) to ensure generalizability.

* 1. **Minimum Protocol for Project Participants**

1. **Consistency in Sample Variation**
2. Variation of samples across different locations must be controlled and balanced.
3. Ensure proportional representation of samples from different regions (e.g., England, Ireland, Scotland, Wales) to avoid bias.
4. Aim for representative sample distribution to support generalized conclusions.
5. **Unified Learning Material Development**
6. Develop a standardized six-lecture course structure to be uniformly applied across all participant locations.
7. All participants must adhere to this fixed course structure to ensure consistency in learning objectives and content delivery.
8. **Division of Teaching Materials by Methodology**
9. Clearly categorize course materials into two methodologies:
10. Traditional Teaching Materials: Conventional lectures and assessments.
11. Gamification-based Materials: Interactive, puzzle-based activities such as escape room exercises.
12. Each participant institution must deliver these materials according to their respective methodologies for accurate comparative evaluation.
13. **Use of Evaluation Matrix**

Implement a mixed-methods evaluation framework combining quantitative and qualitative assessments to gauge effectiveness and engagement comprehensively.

1. **Quantitative Assessment of Learning Gains:**
2. Conduct standardized pre- and post-activity assessments (e.g., quizzes, tests, concept checks) on core AI/ML concepts.
3. Apply standardized scoring methods for reliable comparisons across different sites and cohorts.
4. **Qualitative Evaluation of Engagement and Interaction:**
5. Employ qualitative data collection methods including:
   * + Observational notes documenting student participation and interaction.
     + Reflective feedback from students via open-ended surveys or written reflections.
     + Instructor observations, logs, or interviews noting engagement and challenges.
6. Examples include noting frequency of voluntary collaboration or analysis of reflective writings regarding problem-solving strategies.
7. **Standardized Engagement Surveys and Metrics:**
8. Utilize validated engagement surveys capturing behavioural, emotional, and cognitive dimensions of engagement.
9. Examples include the Student Engagement Questionnaire or appropriately adapted survey instruments.
10. All participating institutions must agree on standardized instruments to maintain consistency and validity of data.
11. **Data Triangulation and Interpretation:**
12. Integrate quantitative test scores with qualitative insights from surveys, observations, and reflections.
13. Ensure triangulated data analysis to robustly evidence the effectiveness of the intervention.
14. **Ethical Considerations and Data Management:**
15. Adhere strictly to ethical guidelines, including informed consent, confidentiality, and secure data handling.
16. Obtain necessary local ethics approvals prior to data collection activities.
    1. **Data Collection**

* Pre- and post-activity conceptual assessments
* Student engagement and perception surveys
* Performance metrics aligned with course assessments
* Structured educator reflections and interviews post-implementation