**1. Revised Research Aim and Hypothesis and Questions**

**After studying recent work in the area and techniques in Procedural Content Generation (PCG), the main research goal and hypothesis are still relevant. However, in this paper, attention will be narrowed to AI-oriented PCG methods, namely those based on Large Language Models (LLMs) and Reinforcement Learning (RL). This more constrained scope should facilitate feasibility and better correspond to the most recent academic developments.**

**Revised Research Aim:**

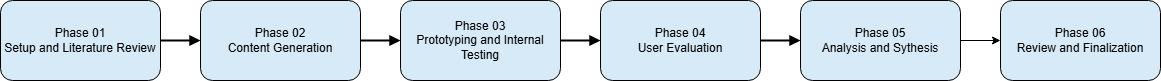
**In addition, we will investigate and assess the impact on game content diversity, quality assurance and player engagement using AI-based PCG methods, including LLMs and RL.**

**Revised Hypothesis:**

**AI-based PCG (LLMs and RL) can support enhancing player learning and content variety more effectively than traditional rule-based PCG, but their efficacy is impeded by issues related to algorithmic unpredictability and issues regarding content quality control.**

**Refined Research Questions:**

1. **How do LLM and RL-based PCG methods measure against traditional PCG approaches in terms of quality and novelty?**
2. **To what extent do players experience engagement, coherence, and enjoyment in AI-driven PCG content relative to rule-based PCG content?**
3. **What are the technical and logistical barriers to adopting LLM and RL to PCGs?**

**2. Practical Pipeline and Timeframe for Research**

**Practical Research Pipeline and Timeframe**

**Phase 01: Setup and Literature Review (Weeks 1–2)**

* **Define the final scope of the research and select PCG methods for comparison.**
* **Extend the literature review from Milestone 2 with a focus on evaluation techniques for PCG.**
* **Set up a lightweight Unity prototype supporting modular PCG systems.**

**Phase 02: Content Generation (Weeks 3–5)**

* **Generate levels using rule-based methods (e.g., tile-based or maze generation).**
* **Generate AI-based content using LLM prompt responses and pre-trained RL agent outputs.**
* **Collect generation metadata includes time, structure, and complexity.**

**Phase 03: Prototyping and Internal Testing (Weeks 6–8)**

* **Build two separate Unity prototypes: one rule-based, one AI-driven.**
* **Conduct internal tests for playability, bug fixing, and balance tuning.**

**Phase 04: User Evaluation (Weeks 9–10)**

* **Recruit 5–10 participants.**
* **Conduct controlled user testing sessions for both prototypes.**
* **Log gameplay data: completion time, retry count, and navigation behavior.**
* **Administer Likert-scale surveys and collect qualitative feedback.**

**Phase 05: Analysis and Synthesis (Weeks 11–12)**

* **Perform statistical analysis on quantitative data.**
* **Apply thematic coding to qualitative feedback to extract recurring patterns.**

**Phase 06: Review and Finalization (Week 13)**

* **Reflect on feasibility, scalability, and research contributions.**
* **Prepare final documentation and presentation materials.**

**3. Proposed Research Methods**

**Experimental Prototyping:**

**Two small game prototypes will be implemented in Unity.**

* **One that is based on rule-based classic PCG (such as modular tile generation).**
* **One employing AI-driven PCG using LLM prompt-generation or pretrained RL agent tuning.**

**User Testing:**

**In brief sessions, subjects (n = 5 – 10) will experience both versions.**

* **Various metrics such as time to complete, number of retries, and in-game behavior will also be tracked.**
* **User perceptions will be collected by aggregated, standardized Likert-scale questionnaires and open-ended questions.**

**Data Analysis:**

**Quantitative results (e.g., engagement metrics) will be analyzed for means and trends.**

* **Thematic coding of the qualitative feedback will be applied to ascertain the themes (e.g., coherence, novelty) emerging.**

**Ethics:**

* **All subjects will agree on informed consent.**
* **It will be a voluntary and anonymous involvement.**

**4. Constraints and Alternatives for Action**

* **Limited technical capacity can result in preventing full integration of LLMs or RL agents: pre-generated outputs can be employed.**
* **Generalization to be hindered by small sample sizes; this study will be a pilot to investigate the covered area.**
* **Results will be interpreted with caution and discussed with consideration of literature.**

**Conclusion**

**This rigorous approach provides a pragmatic and academically founded perspective to the evaluation of AI-based PCG for the game industry. While the scope has been limited, these explicit and measurable comparisons produce useful information on what the modern procedural generation can and cannot do.**