



LIUM

Laboratoire d'Informatique  
Le Mans Université

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15<sup>TH</sup> INTERNATIONAL CONFERENCE ON COMPUTER SUPPORTED EDUCATION

# An Analysis Framework for Designing Declarative Knowledge Training Games using Roguelite Genre

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**Bérénice Lemoine**, Pierre Laforcade, Sébastien George



[berenice.lemoine@univ-lemans.fr](mailto:berenice.lemoine@univ-lemans.fr)

*LIUM Computer Science Laboratory, Le Mans University (France)*

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*with DK training*

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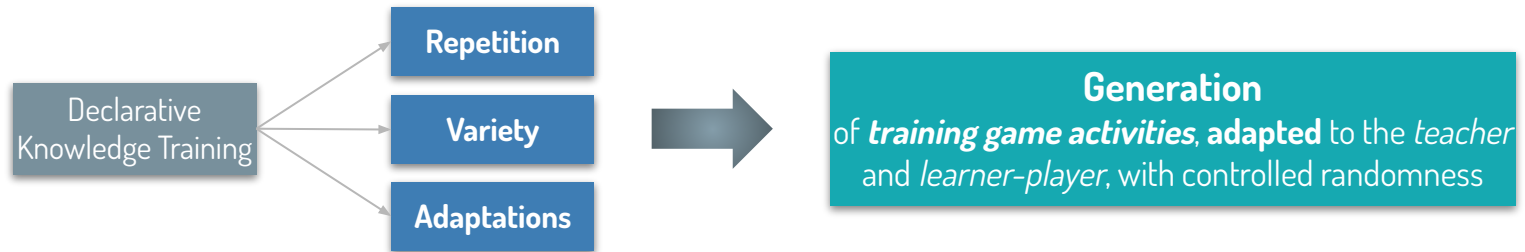
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# Research Context & Overall Objective

- Declarative Knowledge Training through Games 
  - training = providing learners with different forms of questions repeatedly (*retrieval practice*)
  - requires repetition ⇒ need of variety (to avoid boredom)
  - requires adaptations (to learner knowledge, preferences, to teacher's viewpoint, etc.)



How to design generators of adapted training game activities for declarative knowledge ?

# AdapTABLES project



- **Research project in TEL**

- training of multiplication tables for 2nd to 6th grade students


- **Research thematics**

- individualization, activity generation, learning games

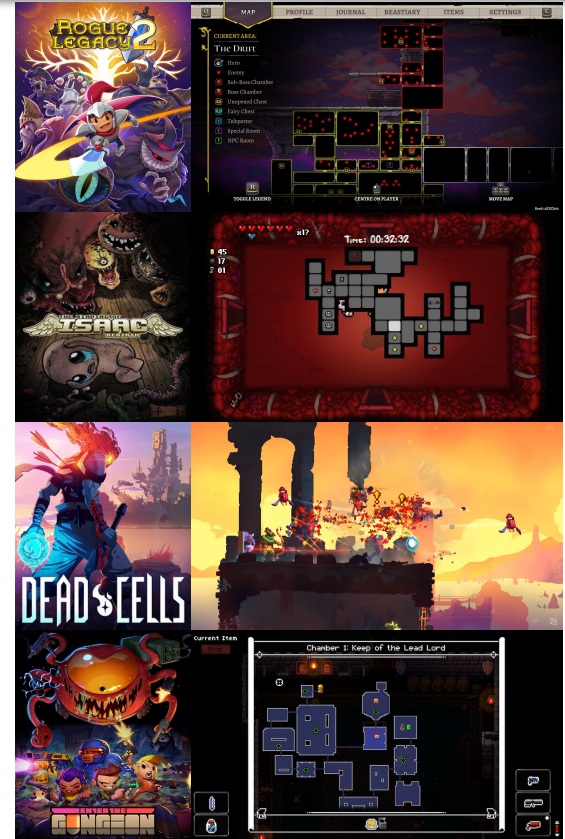
- **Objective**

- Designing, with domain experts, a learning game, based on level generation, for learner-adapted training of multiplication tables
- **Following a** prototyping approach

# A Suitable Game Genre for Training?

- Roguelite is a game genre having for origins 
- Consists of dungeon-like games based on:
  - procedural generation with randomness (variety)
  - perma-death (repetitive game mechanic)
  - progress (limited retention of elements)

A training game activity = interconnected rooms in which the training takes place (*dungeon*)

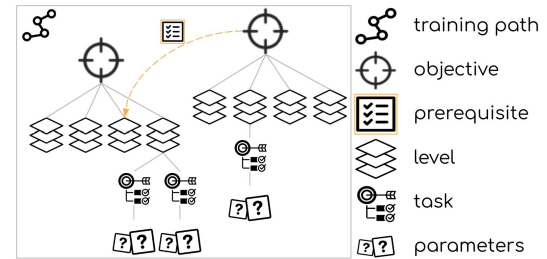


# Adapted Roguelite Training Activities

*A Roguelite training activity is a dungeon where the training takes place inside dungeon rooms*

## Targeted activities adaptations:

- teachers' viewpoint on learners' training through training paths
- learners' level of knowledge through their progression in a path
- learners' game preferences through game elements' selection



# Identified training task types

Completion 1	Completion 2	Reconstruction	Identification	(Non-)Membership Identification
Complete an incomplete fact that has one missing element	Complete an incomplete fact that has two missing elements	Replace, in the correct order, all important elements of a fact	Identify the correctness or incorrectness of one or several facts	Identify elements that share or do not share a given property
$3 \times ? = 15$ $15 = ? \times 5$ $3 \times 5 = ?$	$? \times ? = 15$ -- [3, 6, 5, 10] $? \times 5 = ?$ -- [3, 6, 5, 15, 8] $3 \times ? = ?$ -- [3, 5, 15, 8]	$? \times ? = ?$ [3, 6, 5, 10, 15]	$3 \times 5 = 15$ -- <input checked="" type="checkbox"/> or <input checked="" type="checkbox"/> $6 \times 6 = 35$ -- <input checked="" type="checkbox"/> or <input checked="" type="checkbox"/>	[3, 5, 9, 12, 14, 21] which are results of the table 3?

Each task is specified through parameters

Parameters	Possible Values	Examples
Targeted Table(s)	From 1 to 12	
Multiplicand Position	Left V Right	1x2, 1x3, 1x4.. V 2x1, 3x1, 4x1.
Result Position	Left V Right	1x2=2 V 2=1x2
Multiplier Interval	Integer Min/Max in [1,12]	[1,5] V [5,10] V [1,12]
Element to search	Result V Multiplicand V Operand	1x?=2 V ?x2=2 V 1x2=?
Questions Order	Ascending * Descending * Random	
Response Modality	Choice between propositions V Input	
Max Response Time	Time in seconds	

# Research Question


- Design of Roguelite's activities is inherent to Roguelite's game design
- Prototyping approach  $\Rightarrow$  step by step design
- Many questions to answer:
  - *What is generated? How and when the avatar dies? What are the consequences? What varies? What indicates progress? Etc.*

How can the design of Roguelite-oriented training games be facilitated in a prototyping approach?




# Proposition

A design need analysis framework that makes design choices explicit

- **Two dimensions of analysis** 
  - from the *learning & game perspective*

⇒ keep the *balance between learning and game*

- **Five axis of analysis** 
  - *Generation, Death/Hurt, Variety, Progress, Difficulty*

⇒ game *mechanisms that must be specified* for the design of Roguelites

Criteria	Educational Perspective	Game Perspective
Generation		
Death/Hurt		
Variety		
Progress		
Difficulty		



We do not dissociate adaptation & generation

# Proposition

What are the **consequences** of being injured/killed?

Where can the avatar be **injured** or **killed**?

When can the avatar get **injured** or **die**?

What is **retained**/preserved in-between death?



Generation

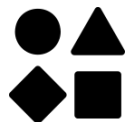
When are they generated?

Which **elements** are generated?

On **what basis** are they generated?



Death/Hurt



Variety

Which **elements** vary?

How do the elements vary?



Progress

What **elements** increase & decrease the difficulty?

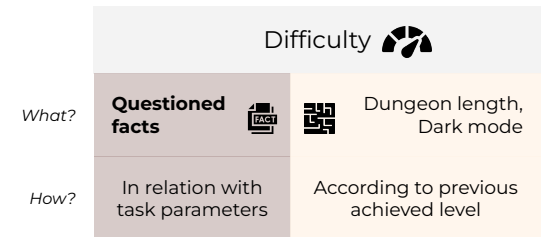
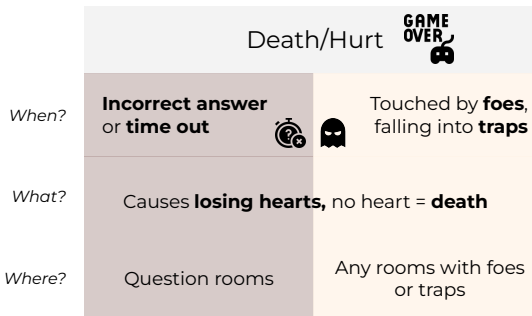
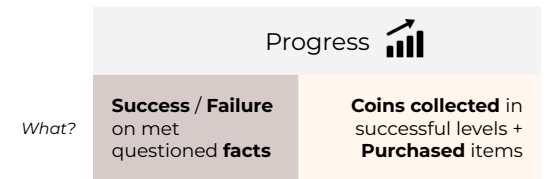
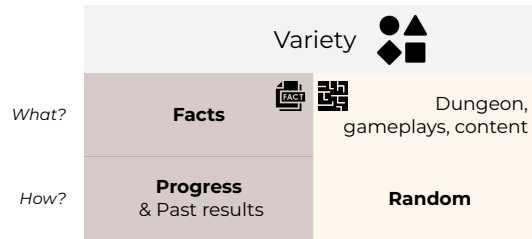
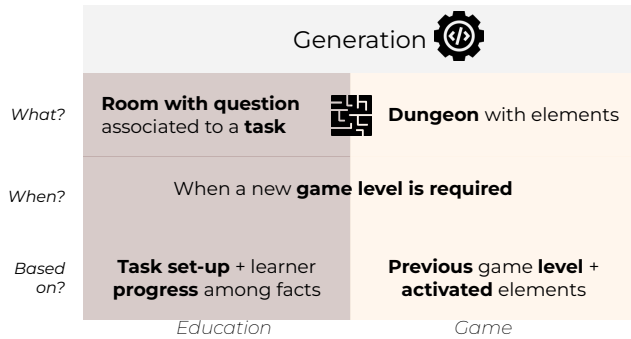


Difficulty

How is the difficulty progression **designed**?

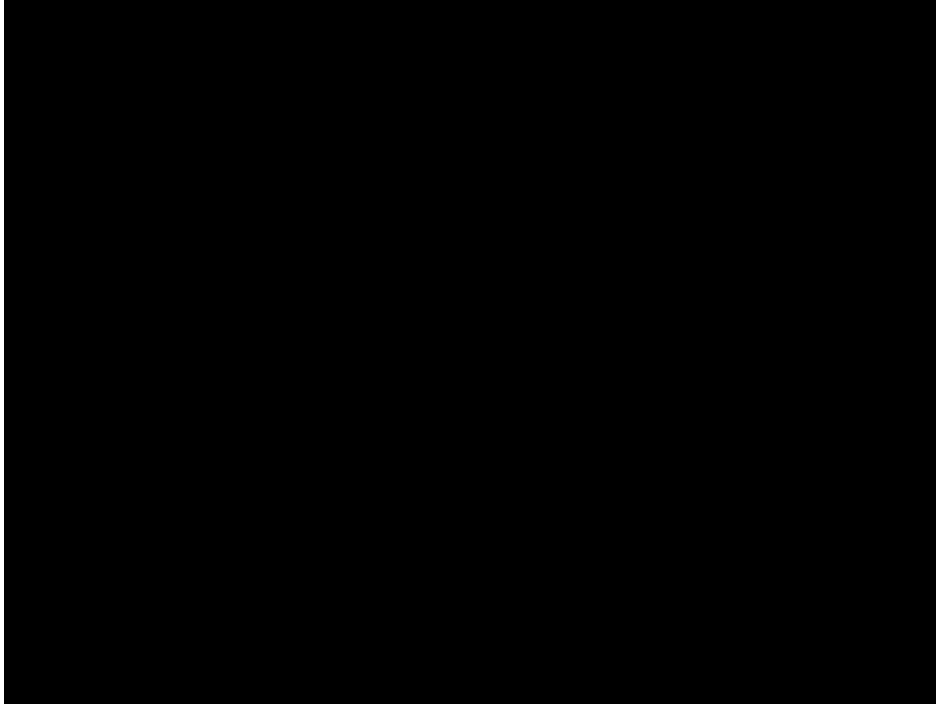
# Framework Application: 1<sup>st</sup> analysis

## Analysis for the 1<sup>st</sup> prototype of AdapTABLES



- Focus on **Completion**
- Task **manually set-up** in game
- Touch approach

# 1<sup>st</sup> prototype & Feedbacks

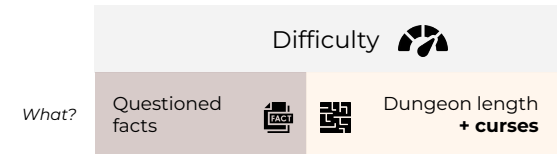
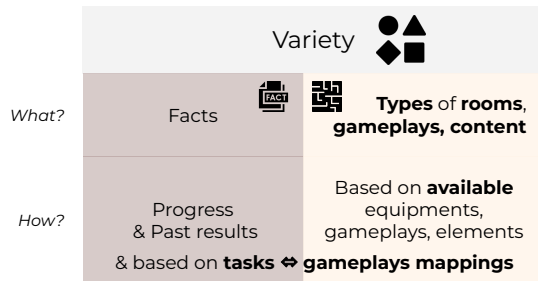
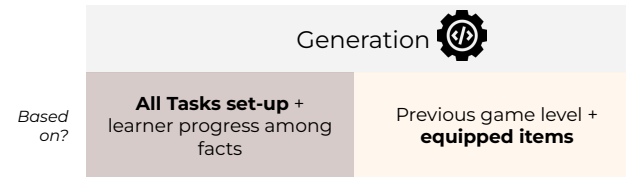


- 3 design iterations
  - Tests in classrooms
  - Informal feedbacks from teachers and learners
- Main feedbacks
  - Death/hurt criterion
    - unintentional choices due to 'touch' approach
    - randomly positioned foes too close to avatar's entry area
    - death caused by game elements in rooms-with-question
  - Variety criterion
    - variety of gameplays was appreciated
  - Foe gameplay considered confusing

# Framework Application: 2<sup>nd</sup> analysis

## Analysis for the future prototype of AdapTABLES

- Task manually set-up in game
- Different purchasable items



# Advantages & Inconvenients

- ✓ Allows the traceability of design choices
  - ⇒ facilitates design evolution
- ✓ Visual representation facilitates the non-neglection of one dimension
- ✓ Support understandable by all stakeholders
- ✗ Very specific context
  - ⇒ training of declarative knowledge through Roguelite games
- ✗ Subjective criteria

# Conclusion & Perspective

- Presentation of Roguelites as a suitable genre
- Proposition of a bi-dimensional design need analysis framework for Roguelite-oriented learning games
- Application of the framework (AdapTABLES)
- In the future: application to other didactic fields
  - Currently working on historical & geographical facts



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Contact us for in-depth discussions



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# Proposition II

Criteria		Educational Perspective	Game Perspective
Generation	Which elements are generated?		
	When are they generated?		
	On what basis are they generated? <i>(sources)</i>		
Death/Hurt	When can the avatar get injured or die?		
	What are the consequences of being injured? Being killed?		
	Where can the avatar be injured or killed?		
Variety	Which elements vary?		
	How do the elements vary? <i>(initiated by player action? Random? Mix of both? Based on a heuristic?)</i>		
Progress	What is retained/preserved in-between death?		
Difficulty	What elements increase/decrease the difficulty?		
	How is the difficulty progression designed? <i>(what impacts? In what order?)</i>		

# Framework Application: AdapTABLES

Criteria		Educational Perspective	Game Perspective
Generation	Q1: What?	One task and one questioned fact per room-with-question	Dungeon + rooms + entry + exit
	Q2: When?	When a new game level is required	
	Q3: Based on?	"Completion 1" set-up Current progress among possible facts	Previous level number and state Activated game elements or rules
		Task parameters have priority on activated game elements in case of conflict	
Death/Hurt	Q4: What?	Incorrect answers or time out	Being touched by foes, falling into holes
	Q5: When?	Injuring causes heart lost, no more hearts will cause death	
	Q6: Where?	Question rooms	Any room with foes or holes
Variety	Q7: What?	Facts	Rooms with gameplay and content
	Q8: How?	Progress and past results	Random
Progress	Q9: What?	Success or failure on met questioned facts	Coins collected during successful game levels + purchased elements
Difficulty	Q10: What?	Questioned facts	Dungeon level length + dark mode
	Q11: How?	In relation with the task parameters	According to previous level number and state

# Future purchasable items





TROUVER LA SORTIE



00:03:37

**PUSH THE CORRECT POT**