Enhancing Active Learning by Developing a Virtual Construction Site Visit Game

Presenter: Cheng Zhang
Department of Civil Engineering

Xi'an Jiaotong-Liverpool University
西交利物浦大學

Outline

- Introduction
- Objectives
- Methodology
- Game Development
- Discussion
- Future work

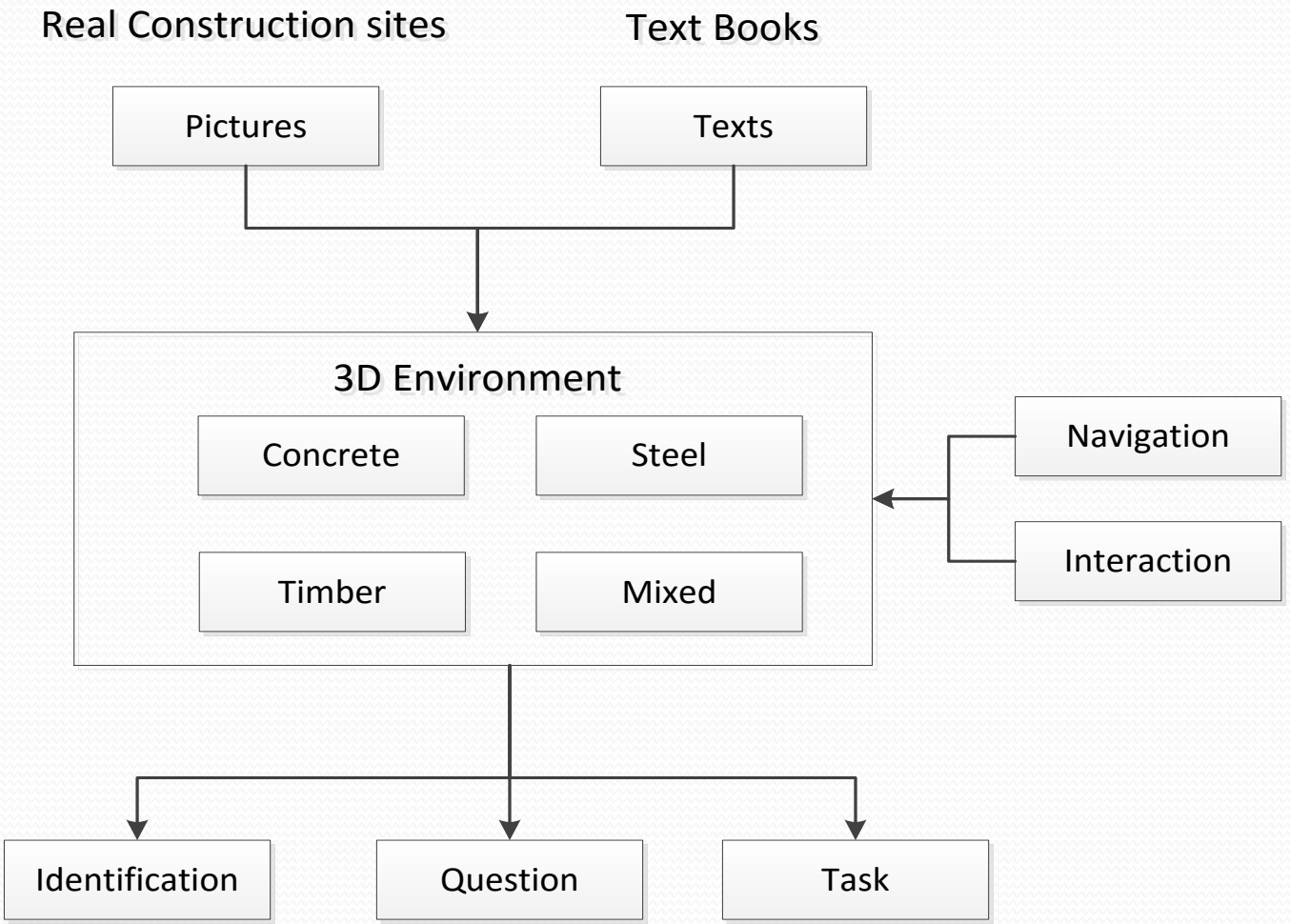
Introduction

- In the Department of Civil Engineering, field trips to construction sites are arranged every semester.
- It is important to gain practical experiences rather than learning knowledge from the textbooks only.
- However, finding suitable and convenient construction sites is not easy.
- Moreover, proper time of visiting construction site is also an extra constraint in terms of availability of the site being visited, and the readiness of proper knowledge engaged to the students.

Objectives

- To develop a 3D virtual construction environment investigation game to enhance teaching and learning
  - to build virtual construction sites by using available resources from previous and current construction site visits;
  - to design a learning and teaching mechanism by providing a visual environment for active learning;
  - to provide an alternative assessment method for civil engineering students.

Methodology

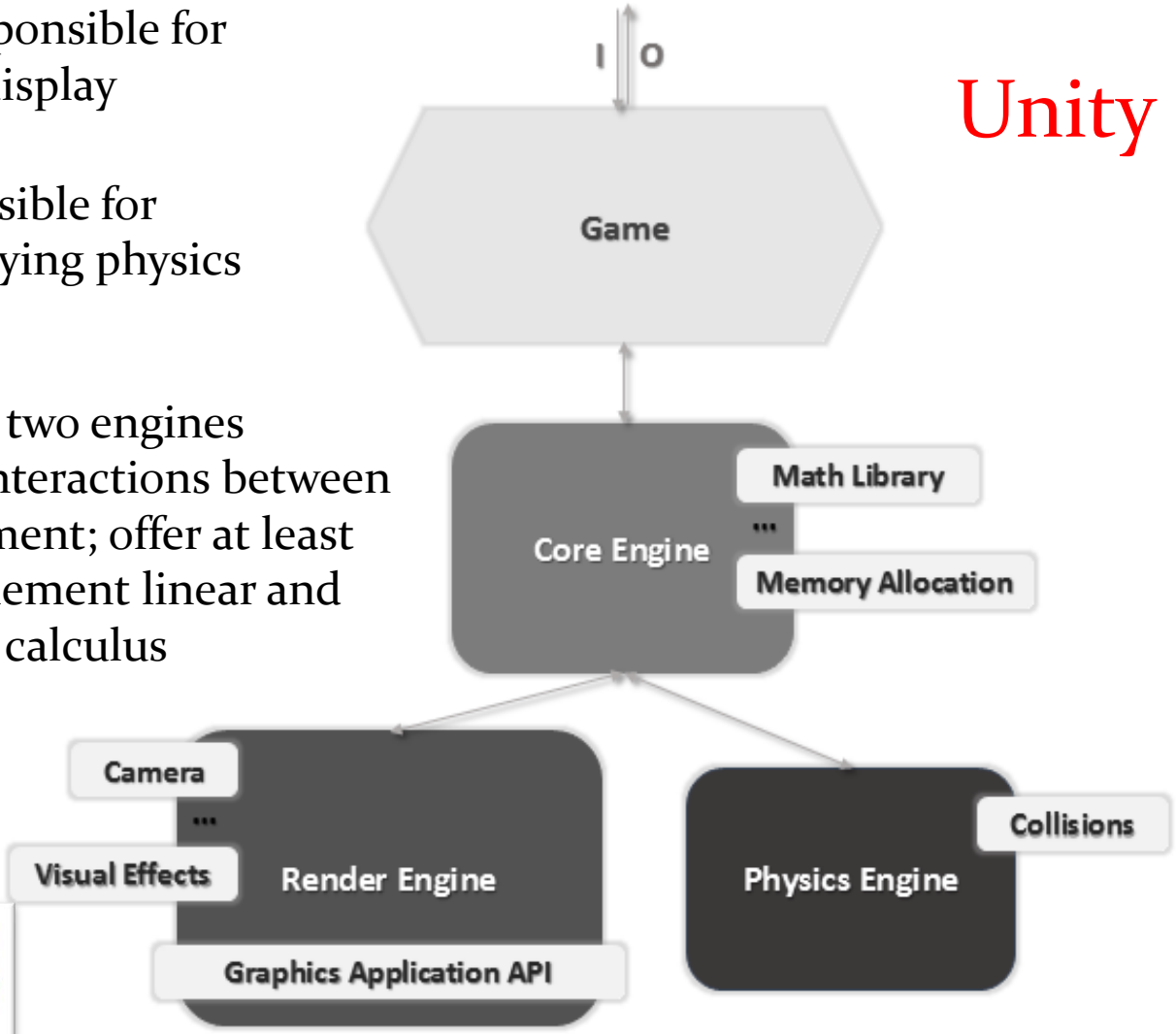


General Game Engine Architecture

Rendering engine: responsible for drawing images on the display

Physics engine: responsible for detecting collisions applying physics on objects

Core engine: bounding two engines together and handling interactions between them; memory management; offer at least one math library to implement linear and affine algebras as well as calculus

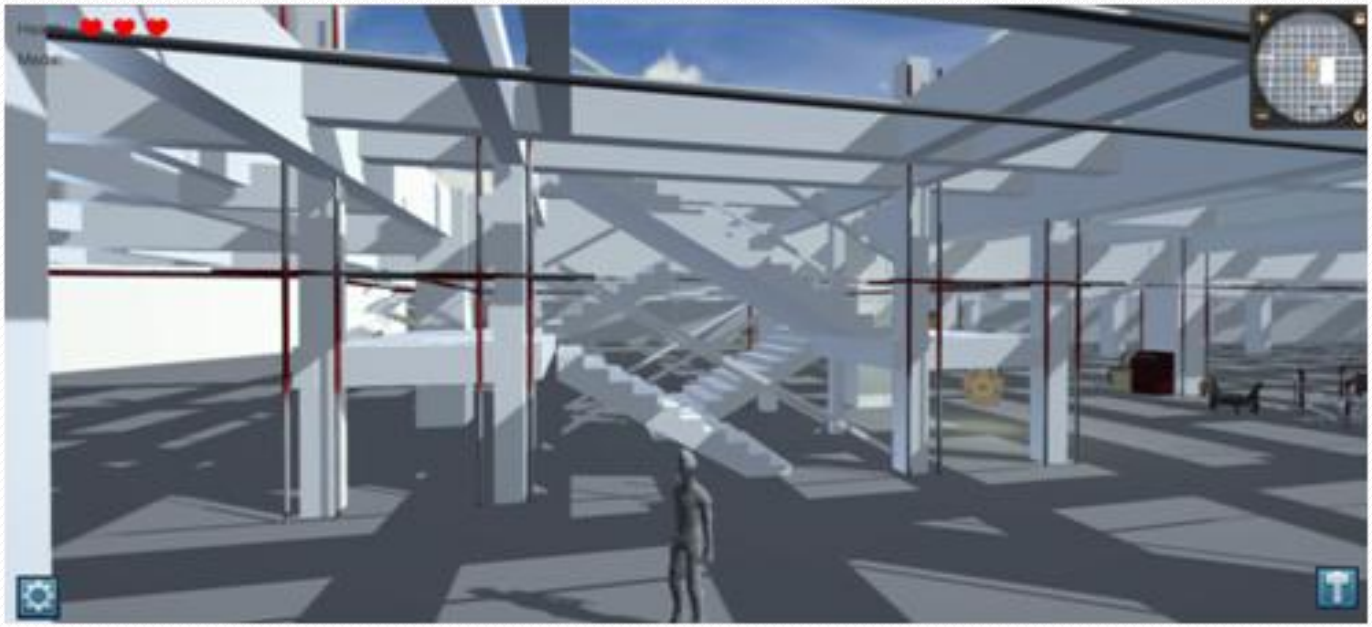


Unity 5

Game Development

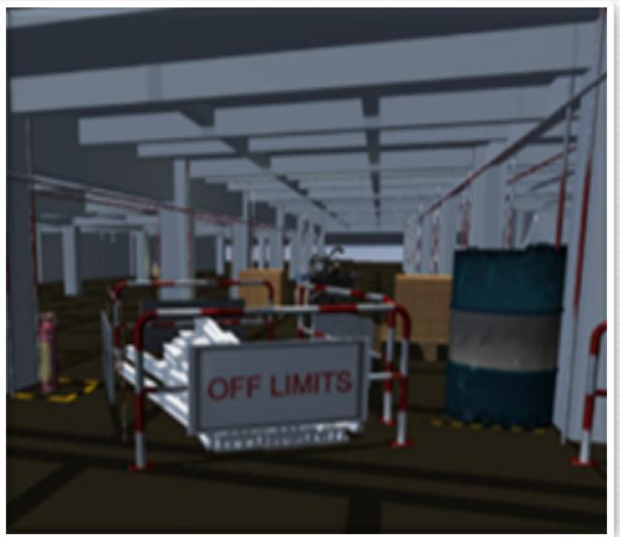
- Constructing Scenes
- Optimizing Rendering Algorithms
- Designing Graphic User Interface
- Designing Questions and Tasks

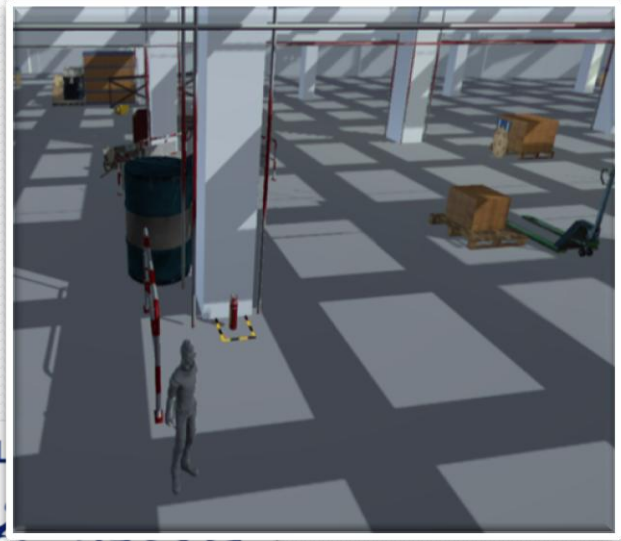
Scenes Construction



•Revit model of a building is used to build the construction site by translating the geometry into discrete vertices
•Physics effects are added to the raw models constructed from those vertices to avoid walking through the walls
•Textures and materials are defined for objects in the scene such as brick, cement etc.

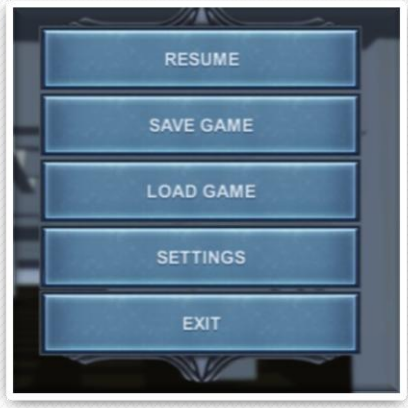
Scenes Construction (Cont.)



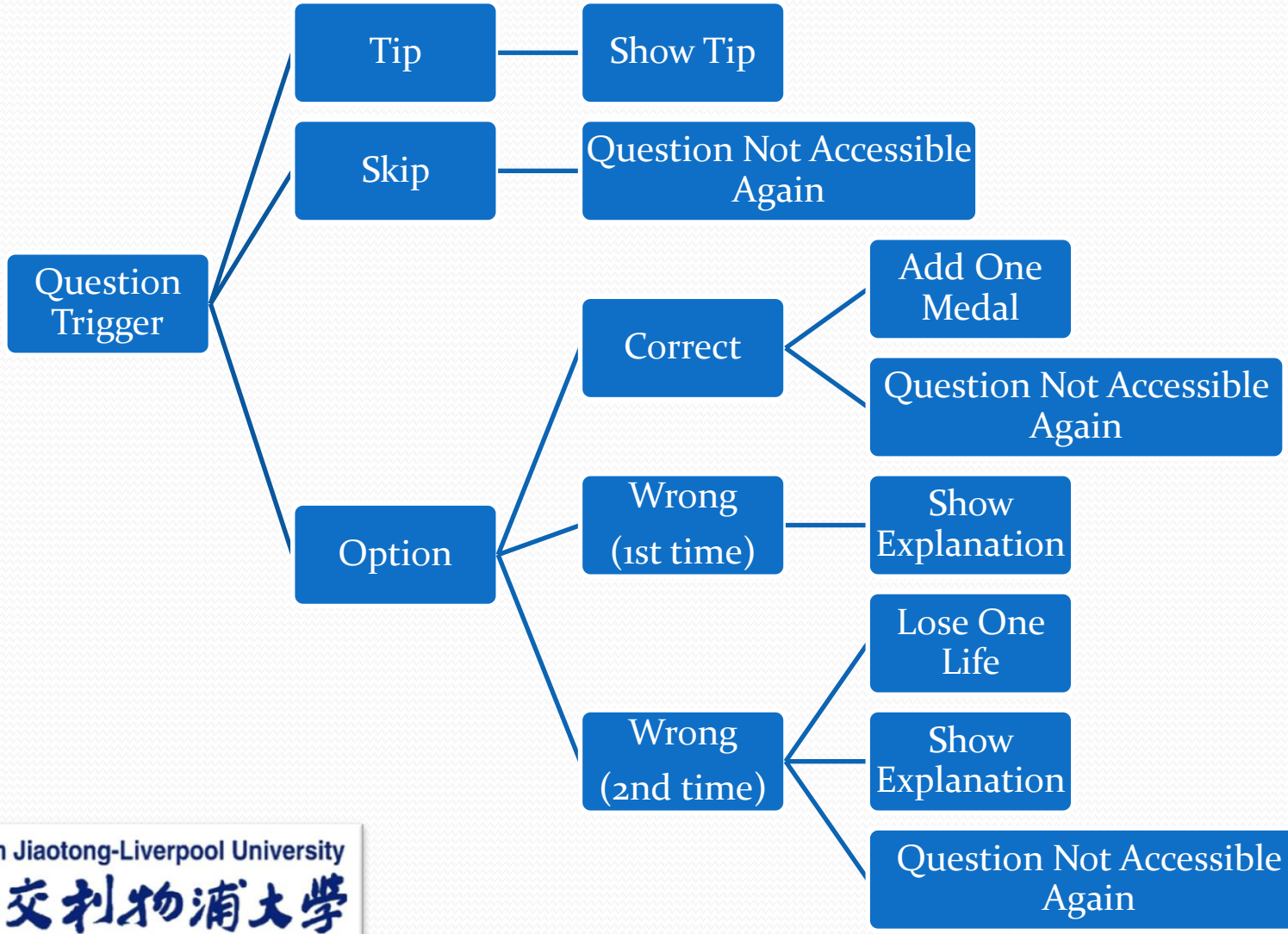


Graphic User Interface Design

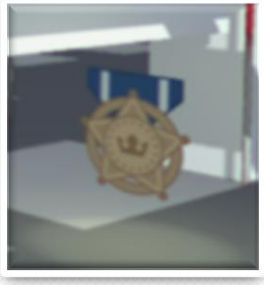
- Menu
  - Providing options at different stages of the game
- Tool Box
  - Providing tools that will be used to fulfill the tasks
- Mini Map
  - Showing the locations of the user and the questions. Upon clicking, the user can be brought to the question directly

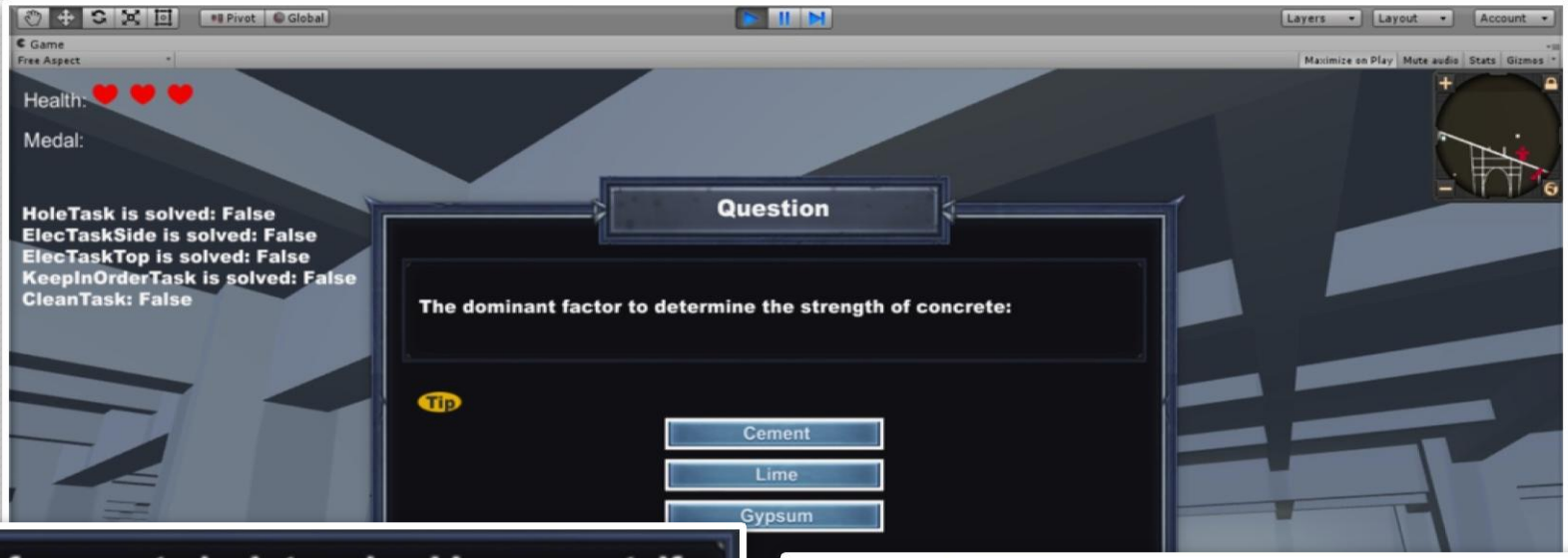


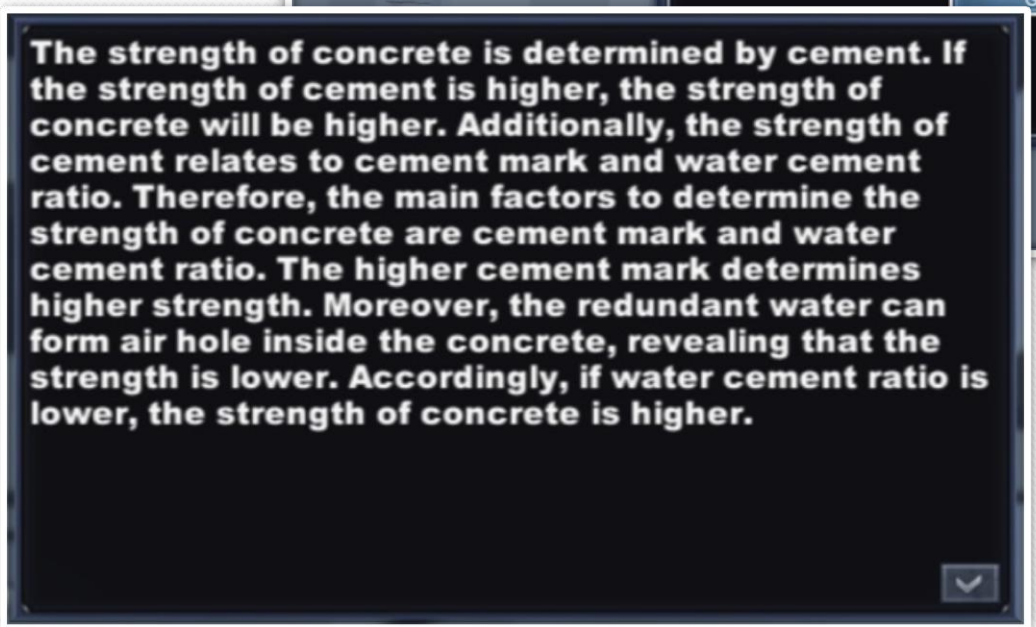
Question Trigger

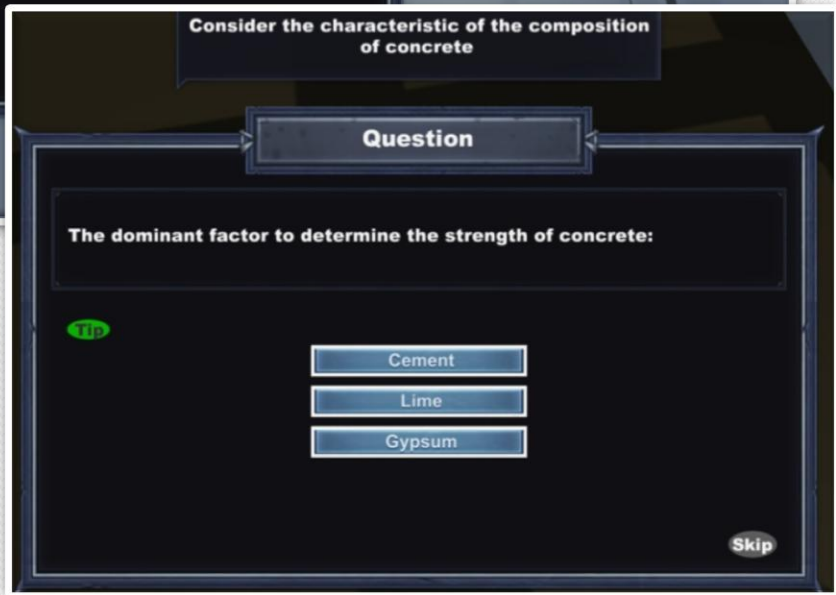


Questions

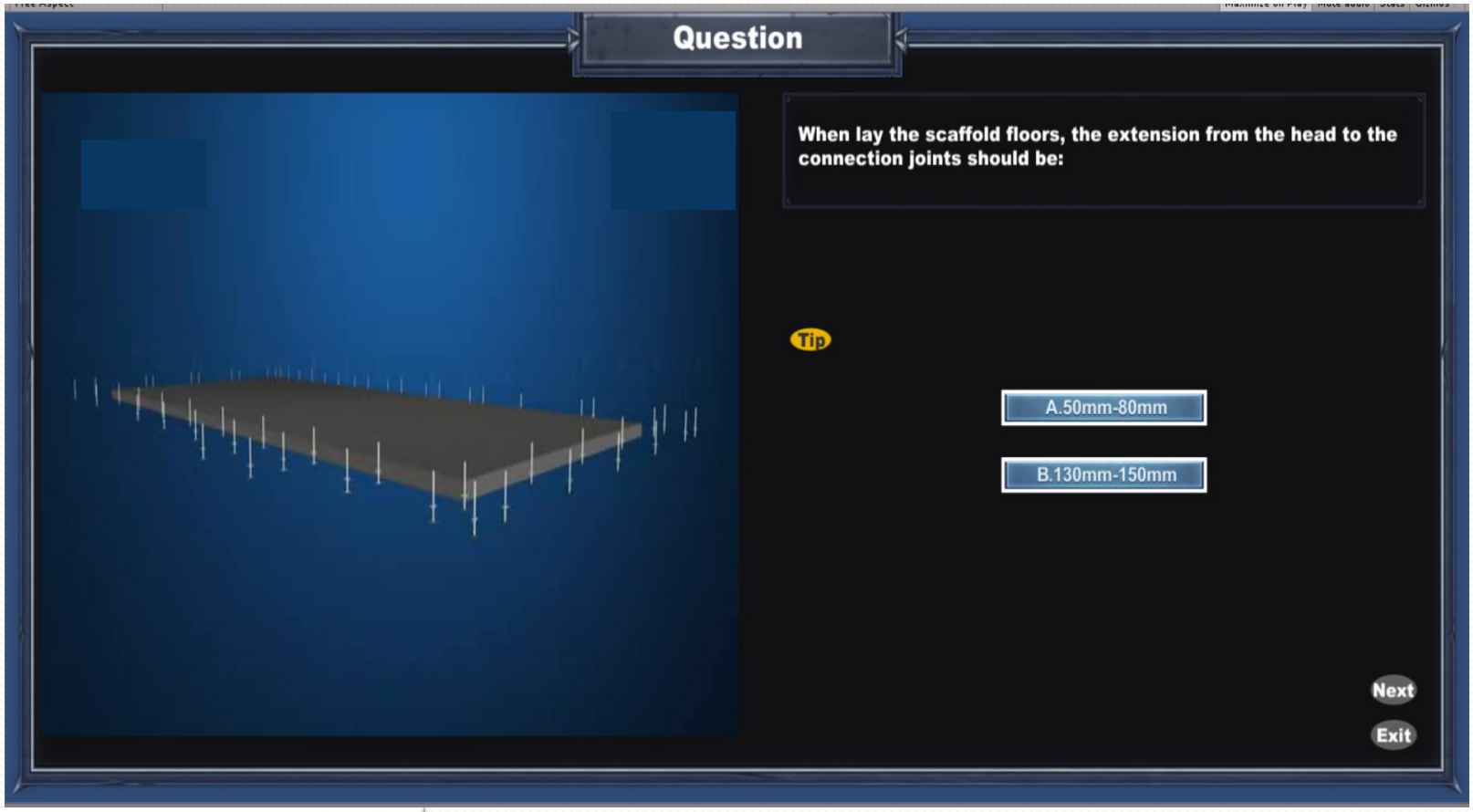



Pivot
Global
Layers
Layout
Account
Game
Free Aspect
Maximize on Play
Mute audio
Stats
Gizmos
Health:
Medal:
HoleTask is solved: False
ElecTaskSide is solved: False
ElecTaskTop is solved: False
KeepInOrderTask is solved: False
CleanTask: False
Question
The dominant factor to determine the strength of concrete:
Tip
Cement
Lime
Gypsum

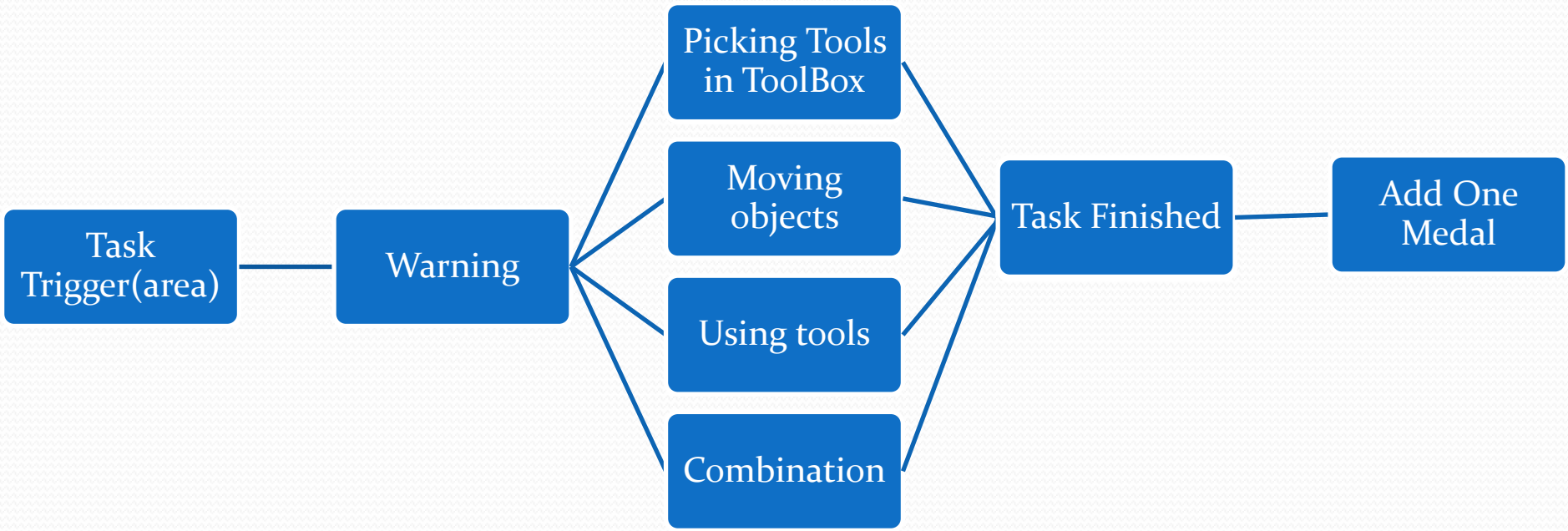

The strength of concrete is determined by cement. If the strength of cement is higher, the strength of concrete will be higher. Additionally, the strength of cement relates to cement mark and water cement ratio. Therefore, the main factors to determine the strength of concrete are cement mark and water cement ratio. The higher cement mark determines higher strength. Moreover, the redundant water can form air hole inside the concrete, revealing that the strength is lower. Accordingly, if water cement ratio is lower, the strength of concrete is higher.


Consider the characteristic of the composition of concrete
Question
The dominant factor to determine the strength of concrete:
Tip
Cement
Lime
Gypsum
Skip

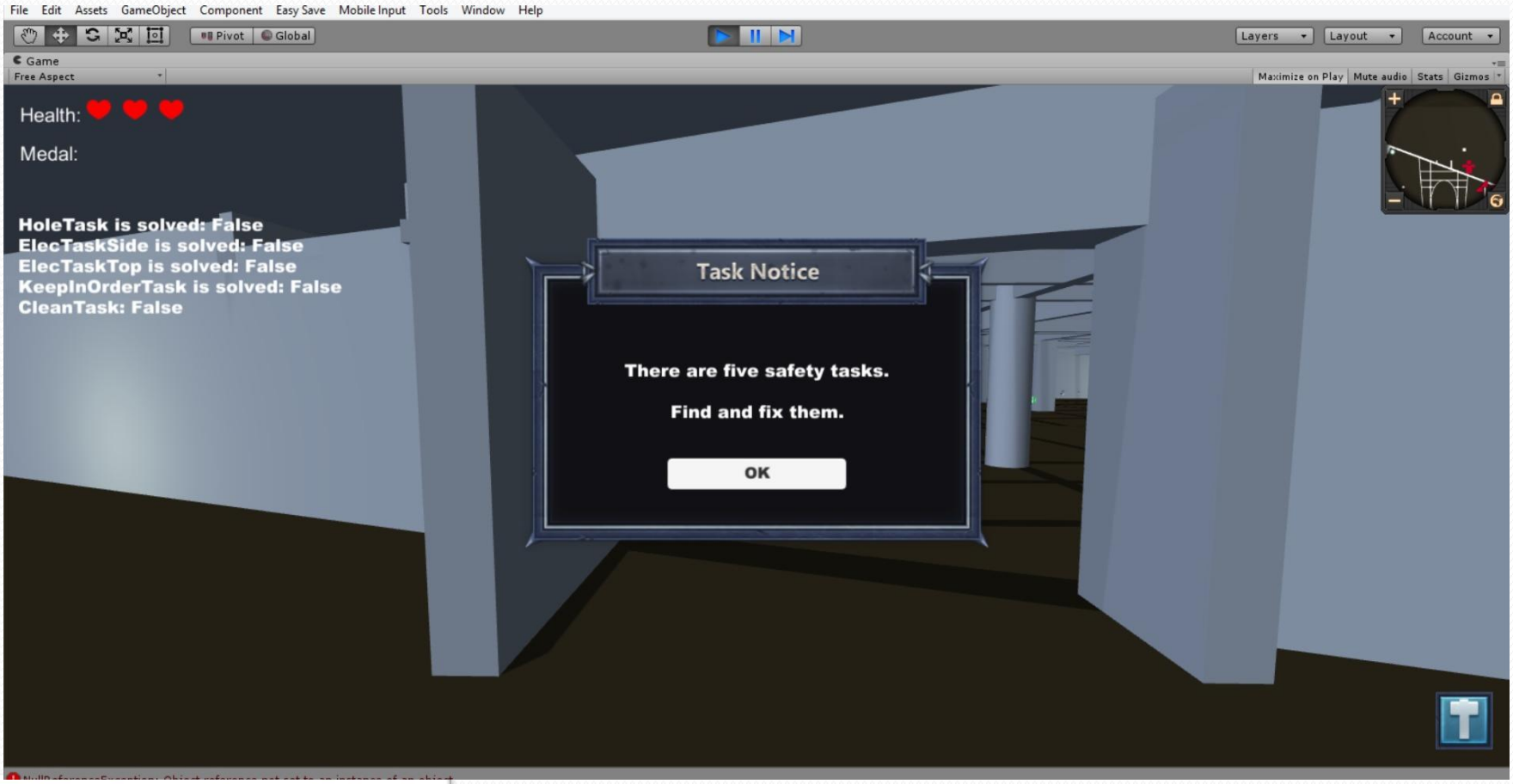
Video Embedded Questions



Task Trigger

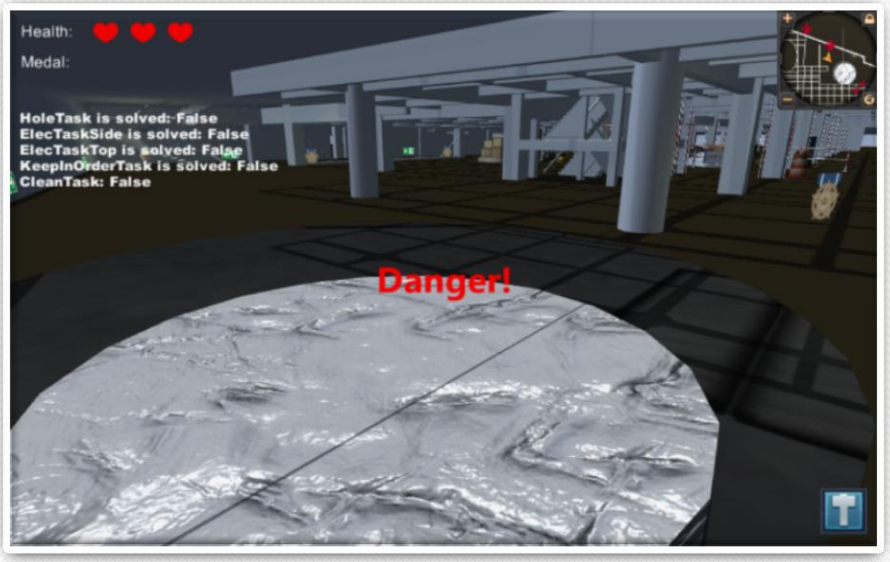


Tasks



Xi'an Jiaotong-Liverpool University
西交利物浦大學

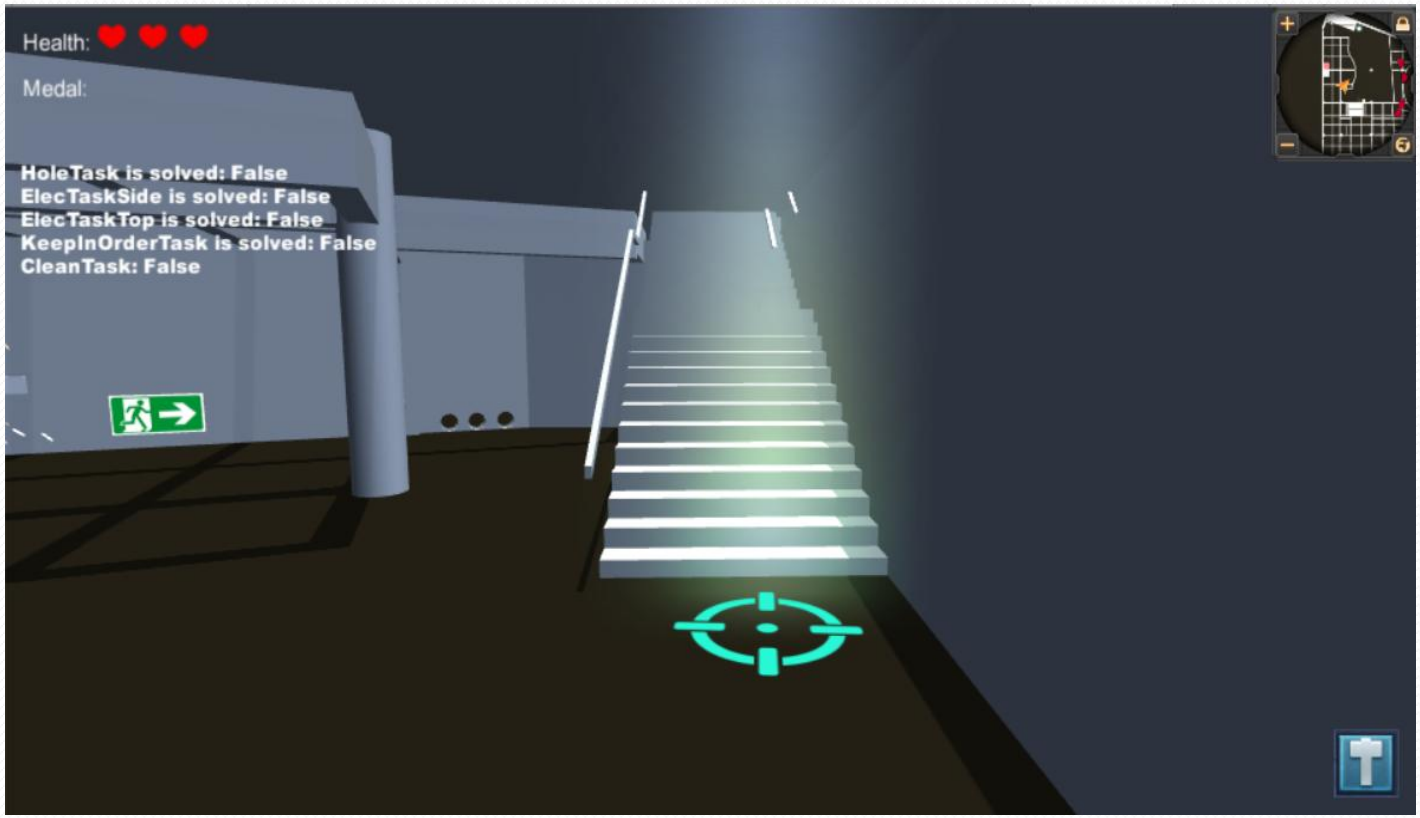
Safety Hazard: Openings on the Floor



Xi'an Jiaotong-Liverpool University
西交利物浦大學

Other Safety Hazards and Problems

Level Up


Health:
Medal:
HoleTask is solved: False
ElecTaskSide is solved: False
ElecTaskTop is solved: False
KeepInOrderTask is solved: False
CleanTask: False

Feedback from students

- 6 Level-3 students (1 international student) were invited to play the game
  - Bugs, suggestions
  - Revision
- 6 Level-2 students (2 international students) were invited to play the game
  - Suggestions

Feedback from students

- The students finished the game within 30 min to 1 hr
- Correctly answered questions counts from 50% to 80%
- Most of them think the game is interesting and want o play again after fixing the bugs
- More Built Environment students will be invited to test the game and give more feedback

Discussion

- This paper proposes a pedagogical methodology for improving the quality of learning through transforming traditional instructional delivery techniques into technology-based learning.
- Students' engagement in the learning process will be improved by establishing a contextual connection between ordinary textbook materials and technologies that students use in their daily routines.
- This new approach will encourage the students to interact, and learn abstract topics in structural design and construction method.

Future Work

- Create on-line versions that can be downloaded by students to their own laptops
- Using Virtual Reality (VR) tools to get rid of mouse operations

Thank you

&

Questions?