Instructional Game Design

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# Problem Statement

[One in ten construction workers](http://blog.capterra.com/13-shocking-construction-injury-statistics/) is injured every year, with rates in Texas exceeding the national average. The most violated OHSA standard is fall protection. Ironworkers are particularly prone to injury. Last year, Millbrook Construction in Texas had a 22% rate of injury. Construction workers in the company with less than two years of experience were found to have a 55% injury rate, with the rate being much lower among more experienced workers. Millbrook seeks to reduce injury rates among its construction workers to under 5% for the upcoming year. Through a needs analysis, instructional designers have traced the cause of the problem to a few batches of rushed training in the previous year due to an unexpected increase in demand for blue collar workers in the state and in the construction industry in particular.

The instructional designers have recommended re-training for all construction workers with less than two years of experience. Because construction is such a dangerous job, Millbrook’s HR department, attorneys, and foremen have advised a form of training that does not further risk injury.

# Proposed Solution

I propose a game simulation with pre-loaded scenarios that cover the most common—and a few uncommon—situations that lead to workplace injury throughout the construction process.

Benefits of this solution:

* Simulated experiences of workplace injuries should increase learner retention of knowledge better than verbal warnings and text-heavy safety manuals.
* Being shown—not just told—how workplace injuries happen should increase intrinsic motivation to heed safety regulations.
* Players can also experience scenarios in which they must perform construction work while minimizing risk of injury to fellow workers.
* Being shown how failure to follow safe practices affects co-workers should increase intrinsic motivation to change behavior. Intrinsic motivators are [suggested by the International Risk Management Institute](https://www.irmi.com/articles/expert-commentary/employee-attitudes-and-accidents/) to be more effective than extrinsic motivators in changing attitudes and behaviors in regard to workplace safety.

# Technology Analysis

The chosen game engine for this project is Unity.

Reasons for using the Unity game engine:

* Can be used to develop three-dimensional environments.
* Graphics capacity can handle both simplistic and realistic representations of real-world objects.
* Allows for first-person player viewpoint.
* Has a large library of assets to speed up development time, including dozens related to construction.
* Physics engines allow for realistic effects in relation to gravity, collisions, and other forces.
* Allows for multiple players over a network.

Limitations of Unity:

* Requires C# programming language; UnityScript no longer supported as of August 2017.
* Requires Windows 7 or higher or macOS 10.9 or higher for development. No Linux support.
* Requires Windows XP SP2+, Mac OS X 10.9+, Ubuntu 12.04+, or SteamOS+ for gameplay.
* Requires a graphics card with DX9 (shader model 3.0) or DX11 with feature level 9.3 capabilities for both development and gameplay.

# Audience & Context Analysis

## General Demographic Information

|  |  |
| --- | --- |
| Information Categories | Learner Characteristics |
| Age | 40 years old on average; recent hires average 32 years old ([EyeOnHousing](http://eyeonhousing.org/2017/06/age-of-construction-workers/)) |
| Sex | 91% male, 9% female ([BLS](https://www.bls.gov/cps/cpsaat18.htm)) |
| Health or Special Needs | workers required to handle lifting 50 lbs. of weight on a regular basis; |
| Ethnic/Cultural Background | White = 63.4 %, Hispanic = 28.9%, Black = 5.8%, Asian = 1.9% ([BLS](https://www.bls.gov/cps/cpsaat18.htm)) |
| Language | 86% fluent in English; 14% functional understanding of English |

## Academic/Educational Information

|  |  |
| --- | --- |
| Information Categories | Learner Characteristics |
| Education completed | 1% bachelor’s degree, 6% associate’s degree, 70% high school diploma or GED, 23% incomplete education ([Sokanu](https://www.sokanu.com/careers/construction-worker/how-to-become/)) |
| Previous related training completed | 100% completed entry-level training with Millbrook |
| Reading levels | 8th grade reading level or higher |

## Specific Characteristics

|  |  |
| --- | --- |
| Information Categories | Learner Characteristics |
| Entry Skills | Groups can perform all necessary job tasks to functional levels but is low on safety skills. |
| Previous or current knowledge of/experience with topic area | All learners have at least one year of construction experience, 21% had at least one occupational accident experience. ([International Journal of Occupational Hygiene](http://ijoh.tums.ac.ir/index.php/ijoh/article/viewFile/229/288)) |
| Attitudes toward content | Group has mixed attitudes toward safety. Education level, exercise, and prior accident experience were strongly correlated with occupational safety attitude. ([International Journal of Occupational Hygiene](http://ijoh.tums.ac.ir/index.php/ijoh/article/viewFile/229/288)) |
| Attitudes toward organization and training division | Group has neutral attitudes toward organization and toward training division. |
| Attitudes toward potential delivery system | Group reported preference for visual learning to oral lecture or text-heavy content. About half of group plays video games (mobile, PC, or console) for at least two hours per week. |

## Instructional Environment/Context

|  |  |
| --- | --- |
| Information Categories | Learner Characteristics |
| Managerial supervisory support | Supervisor will be present during training. |
| Availability of needed technology (hardware, software, etc.) | Commercial client will provide access to computer lab that meets technology needs. |
| Physical aspects of site for implementation | Training environment will be computer lab with two dozen cubicles and workstations. |
| Relevance of skills to workplace | Safety practices and attitude change will directly impact rates of accidents and injuries. |

Comment: Based on this group’s characteristics, it is strongly recommended that the instructional solution be multimedia learning that is not text heavy and uses simple vocabulary, except for industry terms that all workers should know.

# Budget and Timeline

The advanced simulation will come to a total of two hours of training. It is estimated that it will take 716 hours to develop per hour of instruction, which would total 1,432 hours. This would be spread out over the course of nine to ten months, having factored in some tasks occurring simultaneously but also anticipating occasional delays in communication or problem solving. The average cost for such a project is $50,371 per hour of instruction, with a total of $100,742. (Estimates are based on [a thorough study conducted by the Chapman Alliance](http://www.chapmanalliance.com/howlong/).)

# Learning Objectives & Assessment Items

|  |  |
| --- | --- |
| Learning Objective | Assessment Item |
| Player must comply with personal protective equipment (PPE) standards throughout the entire time on the worksite. | Game assessment levels are preloaded with a set of PPEs required for that level. Game detects which PPE items the player has selected from the worktable along with how often the player identified non-playable characters not in PPE compliance and provides a score after the final assessment level is complete. |
| Player must maintain a clear work area during construction to prevent trips, slips, and falls throughout the worksite. | Game assessment levels are preloaded with obstructions. Game detects how many obstructions the player moved to its proper place and provides a score after the final assessment level is complete. |
| Player must identify all environmental hazards and place either a warning sign or barriers in front of them throughout the worksite. | Game assessment levels are preloaded with environmental hazards. Game detects how many and which hazards the player identified and correctly responded to and provides a score after the final assessment level is complete. |
| Player must identify and correct all ladder safety hazards throughout the entire time on the worksite. | Game assessment levels are preloaded with non-playable characters violating ladder safety. Game detects how many and which ladder safety hazards player identified and correctly responded to and provides a score after the final assessment level is complete. |
| Player must identify and correct all unsafe handling of heavy or large objects throughout the worksite. | Game assessment levels are preloaded with nonplayable characters in violating standards for handling large and heavy objects. Game detects how many and which lifting and carrying hazards the player identified and correctly responded to and provides a score after the final assessment level is complete. |

# Instructional Strategy

## Learning Theories

### Types of Learning Outcomes

This training simulation for construction site safety addresses rules and procedures as well as attitude skills. The game player will learn safety rules for construction sites and the procedures for responding to them. Attitude skills apply because the game’s content is meant to illicit a change in choices and resulting behavior.

### Learning theory

This game will make use of experiential and simulation learning theories. This instructional game meets the preconditions for these types of learning because:

* the worksite safety rules and procedures can be experienced,
* experiential learning works for this level of learners,
* experiential learning works for the instructional environment of a 3D simulation, and
* a classroom management plan can readily be produced to manage the learners in a computer lab.

This instructional game suits some of the values of experiential and simulation learning because:

* experience is both an end and a means for achieving the learning goals,
* using an instructional game as the delivery system should be both effective and appealing,
* the simulation will involve authentic tasks and contexts,
* feedback will mimic the real-world feedback the learner would receive from a supervisor, and
* the experiences of the assessment levels will not be “too neat.”

Because the learner will be presented with problems to solve, problem-based learning somewhat applies as well. However, the problems will not be complex and will have right answers because they deal with rules and procedures that must be followed. Problem-based exercises are being used to help simulate real-world problems the learner will face and as a means to internalize the rules and procedures as opposed to assessments that rely on rote memorization.

### Lesson Structure

The lessons structure will combine recommendations from the experiential, simulation, and problem-based learning theories. The lesson will start with “framing the experience” within the game, then proceed to “activating the experience” through the assessment levels of the game, and finally the learner will “reflect on [the] experience” in a discussion with the safety training facilitator.

Framing the experience will involve a non-playable character (NPC) in the role of construction site supervisor acting as lecturer and guide. This NPC will introduce each set of rule and procedure and then present a related problem for the player to solve with the supervisor’s guidance. The supervisor will proceed with each learning objective in turn for the first level (floor level) of the game and construction site.

Activating the experience will occur in the form of a few practice exercises on the first floor before proceeding to the next as well as assessment levels that begin on the second level of the building and will end after the third level on the building’s roof is complete. In these assessment levels, the player will apply newly acquired knowledge until all safety hazards have been identified and responded to.

Reflecting on the experience will occur after all players have completed the game. Then the trainer will facilitate a discussion about the rules and procedures, the logic and reasoning behind them, their purpose, their importance, and the real-world consequences to oneself and others if they are not followed.

A more detailed breakdown follows in the next section.

# Task Analysis

The game is an exploration of a construction site in which the player must learn and then identify potential safety hazards. A non-playable character in the role of supervisor guides the player. Levels within the game are also floor levels—the ground floor is Level 1, the second floor is Level 2, and the roof of the building is Level 3.

The content and player tasks proceed as follows.

## Level 1 (First Floor Outside & Inside Building): Introduction, Lecture, & Practice

* The supervisor NPC introduces the game, its subject matter, and how Level 1 will proceed.
* Learning Objective 1: Supervisor NPC explains the rules and procedures for wearing personal protective equipment (PPE) on a worksite, shows player how to put on PPEs, and shows player how to advise other NPCs to put on PPEs.
* Supervisor then presents an example problem—another NPC in violation of PPE standards. Player practices PPE procedure on example problem.
* Learning Objective 2: Supervisor explains rules and procedures for preventing trips, slips, and falls by removing or cleaning up obstructions and otherwise maintaining a clear work area. Supervisor shows player how to clear a work area.
* Supervisor then presents an example problem. Player practices procedure on problem.
* Learning Objective 3: Supervisor explains rules and procedures for placing either a warning sign or barriers in from of environmental hazards that can’t be easily cleaned up. Supervisor shows player how to put up warning signs and barriers.
* Supervisor then presents an example problem. Player practices procedure on problem.
* Learning Objective 4: Supervisor explains rules and procedures for ladder safety. Supervisor shows player how to properly place ladders, how to properly climb ladders (using both hands), and how to advise other NPCs to climb and stand on ladders safely.
* Supervisor then presents an example problem. Player practices procedure on problem.
* Learning Objective 5: Supervisor explains rules and procedures for lifting and carrying large or heavy objects. Supervisor shows player how to lift and carry large or heavy objects and how to advise other NPCs on safe handling.
* Supervisor presents an example problem. Player practices procedure on problem.
* Player is set free to explore Level 1 to identify and respond to hazards learned from supervisor. Supervisor provides corrective and explanatory feedback when player makes errors. Mistakes and successes on this level will not be scored. Some hazards pose eminent threats to co-worker NPCs and must be caught before NPC gets hurt.
* After all practice exercises are complete, supervisor tells player take the elevator to the second floor, Level 2.

## Level 2 (Second Floor of Building): Worksite Safety Inspection [Assessment Level]

Player must address all hazards on this level before moving on to Level 3. There is at least one hazard of each type.

For each hazard:

* Player must approach hazard.
* Player presses Action button to bring up a set of options to select the type of hazard it is.
* After selecting type of hazard, player chooses from a set of options for how to respond to the hazard.
* Supervisor tells player whether or not they chose the correct response to the hazard. If they did, the game records their success and will count it in the score at the end of the game. If the player chose the incorrect response, the game will count the failure in their accuracy score at the end of the game, and the player must try again until they’ve chosen the correct response.

After addressing all hazards, supervisor tells player to take the elevator to the building’s roof, Level 3.

## Level 3 (Roof of Building): Worksite Safety Inspection [Assessment Level]

Player must address all hazards on this level to complete game. There is at least one hazard of each type.

For each hazard:

* Player must approach hazard.
* Player presses Action button to bring up a set of options to select the type of hazard it is.
* After selecting type of hazard, player chooses from a set of options for how to respond to the hazard.
* Supervisor tells player whether or not they chose the correct response to the hazard. If they did, the game records their success and will count it in the score at the end of the game. If the player chose the incorrect response, the game will count the failure in their accuracy score at the end of the game, and the player must try again until they’ve chosen the correct response.

After addressing all hazards, supervisor tells player that they are done.

Game provides score of:

* hazards identified correctly,
* correct responses to hazards, and
* workplace injuries due to not address hazard in time.