

Puzzle Based Learning (PBL)

1 Introduction:

This puzzle based game consists of two levels: Pin-Pad (brute force attack) and Cryptography (Caesar cipher). The Pin-Pad level challenges the user on their understanding of Discrete Mathematics, more specifically permutations where order matters, and how to apply that knowledge to solve the puzzle. Whereas, the Cryptography levels challenge the user on their understanding of both encryption and decryption of a Caesar cipher. Each student is scored based on their number of tries and time taken to solve the cryptography puzzles and on the total number of tries for the Pin-Pad puzzle. After the student solves a puzzle their score is displayed on a pop-up score board before continuing to the next level. The folder named "PBL" must be stored in the C:\ location to play the game.

2 Controls:

W: moves the character forward

S: moves the character backwards

A: moves the character left

D: moves the character right

Mouse right-button: moves the camera view up, down, left, and right-button

Mouse left-button: allows the user to select options from the in-game menus

H: displays the help menu

I: displays the instruction menu for the respective level

3 Starting the game:

The user will be presented with the in-game start menu where they can select from four different levels:

Level 1: Pin-Pad

Level 2: Encryption with hints

Level 3: Decryption with hints

Level 4: Decryption with no hints

If the instructor wants to view the actual answer (PIN codes, encrypted text or decrypted text) prior to solving the puzzle for teaching purposes then type in *instructor* as the user name.

R: displays the pin prior to solving the puzzle

4 Level 1: Pin-Pad

4.1 Specific Controls: Pin-Pad

Backspace: deletes one value from the entered pin (the character must be inside the red box).

This puzzle simulates a brute force attack against a four digit pin. There are ten tiles, numbered zero through ten, placed on the floor and each value that is part of the four digit pin is signified by a smudge or simple discoloration amongst the rest of the tiles. In order to solve this puzzle the user is required to figure out the total number of different

permutations of the tiles marked with a smudge. The pin is randomly generated and allows a maximum of one repeating digit, thus increasing the total number of permutations.

Once the user has figured out the total number of different permutations of the marked tiles he/she will move the character over each tile to select the values that are part of the pin. The selected values are displayed above the exit door on a black screen. If the correct pin has been entered then the lights will turn green and the exit door will open, otherwise the lights will turn red and the user must enter another pin. To delete the entered pin the user can either step on another tile or simply hit the backspace key on the keyboard. The backspace key can also be used if the user has accidentally stepped on the wrong tile.

5 Cryptography

Specific controls: Cryptography puzzles

Q: rotates the cylindrical object counter clockwise

E: rotates the cylindrical object clockwise

Enter: submits the rotated objects

The cryptography puzzles are using a Caesar cipher also known as a rotation cipher. Each puzzle uses the English alphabet where each letter of the alphabet is displayed on a cylindrical object. When the user walks up to one of the objects a spot light will appear above the character thus signifying that they can now interact with the object. Pressing or holding down the Q button, on the keyboard, will move the object counter clockwise and pressing or holding down the E button, on the keyboard, will move the object clockwise. When the user believes they have chosen the proper rotation he/she may simply walk to the next object. When the user has rotated all cylindrical objects to the chosen letters he/she will then press enter. If the lights turn red then one or more of the rotations are incorrect and the user must figure out which ones are incorrect. Otherwise, if the lights turn green then the user has successfully chosen the correct rotation for all the objects and may move forward to the next level.

5.1 Encryption with hints:

In this puzzle the user will be encrypting a plain text message. This version of the puzzle gives the user hints by displaying the mapping from the plain text to the cipher text. If the user knows at least one mapping from the plain text to the cipher text then the user simply counts the number of rotations and applies them to the rest of the message. The hints will be known because they will not have an object for the user to interact with.

5.2 Decryption with hints:

In this puzzle the user will be decrypting the cipher text to the plain text message. Hints are given to the user by displaying the mapping from the cipher text to the plain text message. If the user knows at least one mapping from the cipher text to the plain text then the user simply counts the number of rotations and applies them to the rest of the cipher text. The hints will be known because they will not have an object for the user to interact with.

5.3 Decryption with no hints:

In this puzzle the user will be decrypting the cipher text to the plain text message with no hints. There are many methods to solve this puzzle such as frequency analysis, finding plain text words of the same length, and last but not least knowing which letters in the alphabet are used the most. These are only a few methods that will aid in solving this puzzle.