Universiteit Leiden

Master Computer Science

Rhythm Climber, using rhythm on pcg for climber

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Abstract

To aid teaching, educational games are becoming more popular. Games often provide a more direct reward for getting questions right and provide some additional challenge that distracts from the learning. At the end of session of games you want to reward the children for completing it and give credit when they get most if not all question right. These rewards can be a variety of choices. The most common approach would be some kind of badge to show of to others. Giving some currency like coins also works for this purpose. For this project we looked at instead creating a relaxing game that both provides coins, but also provides a different challenge for the children to overcome. The only has a single input, jumping, making the game easy to understand. There are plenty of coins spread out to collect by the player. The game also limits how far the player can fall which makes the game less frustrating. However creating every level by hand is a lot of work, which is why we try to automate the process. In addition to this we will involve some rhythm to the placements to get the player in the flow-state. This flow state is often important for the player to enjoy the game fully as as no point should the game feel to difficult or too easy to complete.

1 Introduction

In education it is important to get the attention of students and provide rewards for completing these tasks [2, 13]. Rewards are often an important tool for primary education, this count for both behaviour management and academic performance [10]. For example, sticker are used and, with the increasing digitalization of education badges are also getting more popular [3]. This form of gamification is getting more popular in educational environments. In gamified digital systems, the teacher does not have to directly monitor performance to give badges out, and at the same time achieving similar results. This convenience and effectiveness are but a few reasons that make educational games increasingly popular nowadays. Here game elements are used to present and solve educational questions. For example, the game proves the question like normal, but have the answer involve some game challenge, like shooting an arrow at the correct target. This makes the exercise more involving and create some diversion from the exercises. To reward completing these exercises, and motivate learning to answer correctly, appropriate tools should be used. These could consist of, for example, a badge system [9], in-game currency [5] or, in case of this project, a fully engaging and "fun" game. This game should be relatively easy, not educational but a fully entertaining activity. An additive goal would be to provide relaxing, create a different challenge and most importantly provide a sense of achievement. In Section 2 the concepts used in this project are introduced. Following in Section 3 the problem is defined and expanded on after which the methods used in the project are introduced in Section 5, the results of which are shown in Section 6. Finally the project will be concluded in Section 7.

2 Context

The game that will be used is part of the education system from `Squla`. Squla provides digital educational games that can be used alongside regular education. Retaining knowledge over the course of a vacation is one such application. The platform provides two major games aspects, their own created educational games and the use of gamification. An example for such a game

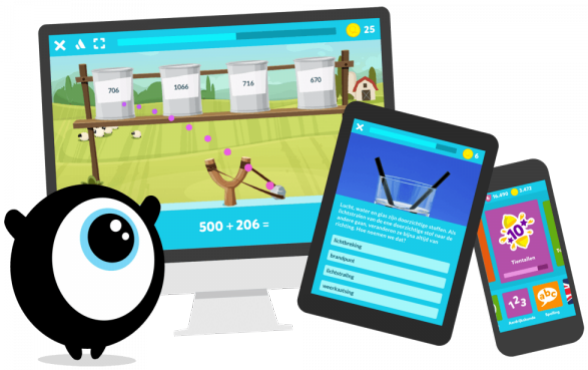

Figure 1: A picture from Squla showing some of their games.

involves presenting a regular question, like a simple summation, and the user is tasked to shoot down the correct answer from multiple targets. Some of these games can be seen in Figure 1. Instead of just challenging the user by shooting down targets, solving the question is equally important, making this an educational game instead of "normal" one. The user goes through several of these games in a single session and gets an additional reward at the end for the completion based on the amount of correct questions. This type of education can reduce the information loss over the span of vacation as shown in [4] Squla also uses some gamification on their platform, that is, the use of game elements outside of a game, for example providing a level up system on a blog website. The user can collect coins by complete sessions which can be used to get avatars or small physical rewards. The user can also collect badges for completing certain goals like completing sessions with few mistakes, which will give additionally provide coins. The use of gamification can be used to aid education by increasing the learning rate as shown in [1, 12].

As part of their system to provide extrinsic motivation after a series of questions, the user may chose a reward. One of these options is to play a simple climber game in which the goal is not to answer questions, but they user is instead is free to collect as many coins as possible whilst trying to get as high as possible within 30 seconds, as seen in Figure 2. Note that the user can also choose to take set amount of coins as well, so the game should provide more to make it interesting. When the game starts a character will begin moving from right to left and switch direction when it hits a wall. The player has access to a single input, a jump button. The longer the button is hold, the higher the character jumps. During the jump the player also keeps their horizontal momentum resulting in an arched jump rather than a vertical leap. After 30 seconds the game ends, after this the collected coins are added to the total on their account and the session ends. The two means of progression, that is collecting coins and gaining as much height as possible, are intertwined. Stay in the same area for too long to collect coins, and there are less coins to collect, which may yield less coins over the course of 30 seconds. However if you focus too much on gaining height, this may result in skipping too many coins. Our research will use this game to look for possibilities to apply procedural content generation and what its effect is.

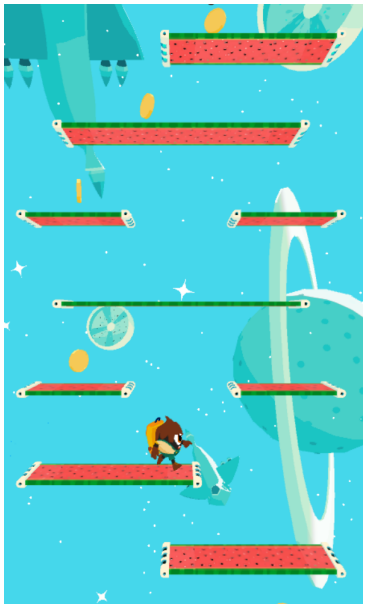

Figure 2: An example state of the climber game

3 Problem definition

To purposefully create levels can be difficult task, the game should be rewarding and provide some relaxation after previous the exercises. Moreover the game also contains functional objectives such as coins to collect and the possibility to get as high as possible. It is important to find the correct balance in the objectives, that is, placing down enough coins to keep the player engaged and interested. The difficulty of the game is a great factor, if the game is too easy or too difficult, the player loses interest. To get someone invested into a games the `flow` is very important as mentioned in [8]. The concept of flow encompasses this project nicely; if the game is too difficult the player will just get frustrated and stop playing the game, but make it too easy and you will get bored. It is important to strike a balance between the two if you want the attention of the player. This sense of flow can be depicted in a flow channel as seen in Figure 3, as the skill increases so should the challenge. Considering that the target group is between 8 to 12 years old, the game should be relatively easy, where even making a mistake, like missing a jump, should yield some coins even if you would get fewer over the entire duration of the game.

This difficulty should be reflected in the game-play, that is every level be made with the flow in mind. Creating every level by hand will allow the creator to ensure that this state of flow is maintained as much as possible, however it will also be time consuming and, given that the user may play this game multiple times, the levels may get too predictable. The former is even more so the case when the game becomes bigger and longer. Using Procedural Content Generation (PCG for short) can reduce this problem. With PCG the computer will generate the level according to some algorithm rather than having to make everything by hand. When the amount of work that the program has to generate (and by effect the time it takes before the game generates the level) increases, the strain on the design reduces, but also the control shift to the algorithm allowing the levels to be more random. This loss of control may result in levels that do not make sense or are straight up be impossible. A simple approach would be create a collection of segments which are randomly layered onto each other, which is used in

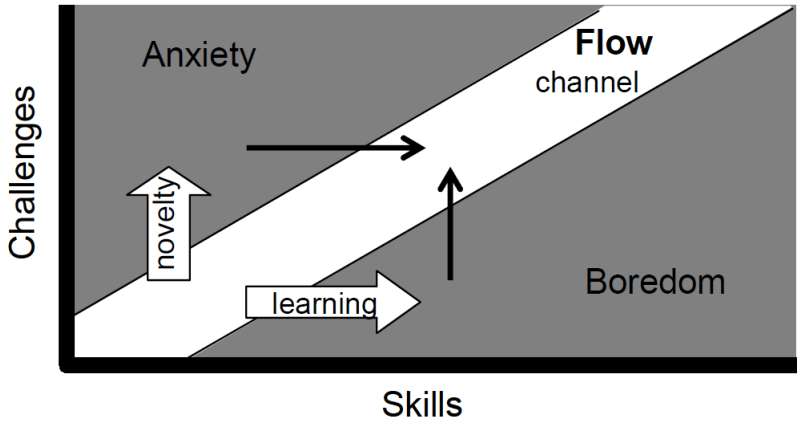

Figure 3: Flow channel diagram from [6]

the initial situation, the `original` version, but this may get repetitive at some point. Instead it might be interesting to make it more random, but at the same time ensure that the levels are sensible and get the player in a flow state even after taking the game another time. To this end we will look at creating some kind of rhythm that makes the game predictable enough that the player gets in a flow state whilst avoiding making the game to repetitive. This should help ensuring the each level is possible to complete as well. Therefore we question if "How PCG be used in a vertical platform game with only jump to create a relaxing experience?" and "How rhythm in a platform game be used to create a relaxing experience?" by using the given platform game as an example.

4 Background

Flow is of big importance when creating a game in general. This was first considered by Csikszentmihalyi [7, 8] and is described as a state of mind when focusing on a specific task. This sense of flow can be as broad as reading book, watching television or playing a board game. When the mind is not focused on something, it is in a state of chaos. Something as simple as random television program is enough to settle this chaos. A game is different as the user is not only watching, but is also actively participating creates new angles of opportunity. This idea is further analysed [11, 6], which yielded the graph seen in Figure 3. The flow channel has become a popular figure when considering the difficulty of the game, how do you keep a player interested? Getting the attention of the brain is relatively simple, but keeping it difficult. There is no problem if the game starts easy, but as the experience of the player grows, the game should likewise become more challenging. The game should contain some novelty, which may obtained by introducing new features or by making the current goals more challenging. In some cases simply changing the challenging in new ways that are not too predictable may be enough to keep the attention. Games of the rogue-like genre use the all the time, the challenge does not change, but as the items that are provided change at each run, the game stays interesting. If the difficulty scales too slow, the game becomes boring, but scale too fast and the game becomes frustrating. For rogue-like games this is often done by making the enemies more difficult as time passes, but even playing the same difficulty over and over again can still be interesting as no run is the same. For this project the target group is children between 8 and 12, and along with the goals of the game, that is a relaxing experience, the

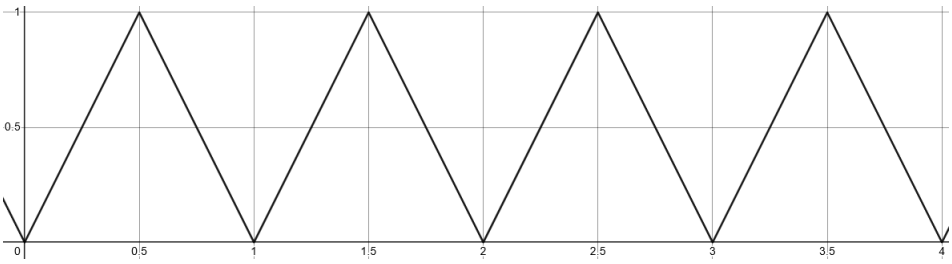

Figure 4: A part of the triangle wave

game should be easier rather than making getting attention out of the challenge it presents. The flow of the game will be used to keep the game interesting for the entire duration, 30 seconds in total. The game may be played multiple times, all the user has to do is go through a session of questions and the game can once again be chosen, at which point the game should still be interesting. Make it to easy and the player gets bored, but make it too difficult and the players will simply quit because they get nothing done. Both ends yields the user never choosing the option again whilst we would like them to chose it every so often, instead of taking the coins immediately. Sometimes this means slowing the game down at times to allow the player to familiarise with the controls and create a breather or to speed it up to keep in interesting. In this game we have a vertical platform game where the only control is a jump. Because the player automatically moves a rhythm becomes natural, the frequency and duration of pressing the jump button. The time spend moving from the left wall to the right and back is always the same. When the time is plotted against the horizontal position of the character a triangle wave is formed as seen in Figure 4 and can be described by the formula:

$$y = 2|x - \lfloor (x + \frac{1}{2}) \rfloor|$$

In this figure a jump can be described as an interval on the x-axis describing when the character is airborne. This figure changes when the player is sliding on a wall. When this happens the character no longer moves horizontally for the duration of the slide decreasing the frequency. Because we are focusing on the rhythm by making jumps at a certain frequency, wall slides are not included in this algorithm.

5 Method

Taking rhythm in mind when using PCG to generate sensible levels requires some definitions and rules. The climber game is a simple platform climber in which the player is tasked to get the `character` as high as possible. The character moves by itself from left to right, switching direction when it hit a wall. We will call a single move from left and right a `pass`, the same counts for the reverse. The player has a single input `jump`, the high ranges by how long the button is held. The character, as expected from a platform climber, is affected by gravity. To prevent the player from falling forever the game contains `platforms`, these platforms are solid on top, but the character will move through the platform when approached from the bottom. Finally the walls of the map have some interesting interactions with the player. Apart from changing the direction, the character can `slide` of them (given that there is no platform directly below it) and even jump of it, known as a `wall jump`. Jumping, sliding and wall

jumping are all `actions` that the player can use to get from platform to platform. The left and right movement is not considered here since the player has no influence over it, but will be important for the location of the platforms.
Two platform x and y are considered `connected` if and only if there exists an action that allows the player to move from platform x to platform y without touching another platform. Following from this a `path` is defined as a set of connected platform that allow the player to move from the lowest platform to the highest platform. Every platform we create should be `reachable`, that is, there exists a path from the starting platform to this platform. For most levels this will be the case as long as there exists a path to the top. Falling is an effective way of reaching platforms in most cases. Along its path the character may pick up `coins`, the main goal of the game. The player is limited by time, after 30 seconds the game is over, leaving all the uncollected coins behind.

5.1 Generation

With the rhythm and game constraints in mind, the next goal will be generating every level. The level should be an array in which every position is one of three possible options, empty space, a coin or platform. Starting with a "tutorial" array and working from that seemed more difficult than it should be, it is difficult to find out where the jump should take place and what you can change taking the rhythm into account. That is why the program will instead remember the *intended* rhythm and generate a level (array) around this. This rhythm will remember the position of the jump, the distance and height it is intended to make, where the polarity of the direction denotes the direction, and the type of jump, how long the button should be hold for, implemented as simple max distance and max height. Given the maximum height h, maximum distance d, realised height y and realised distance x, the following formula approximates the realised height:

$$y = \frac{-4hx^2}{d^2} + \frac{4xh}{d}$$

In most cases however the reverse is used, that is:

$$x = \frac{d(1 + \sqrt{1 - (\frac{y}{h})})}{2}$$

The proof that these equations are symmertrical is shown in Appendix A. To create a level the first still is finding the first jump position. After that the program looks at the jump distance and jump height to discover where the player should land. In this algorithm a coin is placed one space above, and platforms below as wide as a predetermined `deviation` on both sides. After this the new jump point and distance are called on. Now there are two options to ensure that all platforms involved with the jump are connected, either the direction of the jump is the same, or the character has to change direction. In the first case the platforms from the previous jump have to extended towards the jump point plus the deviation. If the player switched direction, however, the platform should extend towards the wall, so that the player can switch direction, and go up to the jump point with deviation (or more if the previous end-point of the jump is further away). Finally at the start and end of a level, a line of platforms going from wall to wall is present to ensure the player cannot fall from this point. Using this method there exists a single path from bottom to the top of section as the wall jump and slide are excluded from the available actions. The addition of catching platform, that is platforms that catch the

player when they miss a jump, is not used as the rhythm would become more complicated. The same goes for the coins, coins outside the rhythm are nice, especially when making mistakes, but may confuse the player of the rhythm. Making sure that all the coins are reachable by following the rhythm is intended for this experiment.
The game has a total of three different levels. When the reward is chosen for the first time, level one is presented to the user. If the player gets enough height, which is saved between games if not achieved, the next time the game is played, the second level is chosen and similarly level three. The first level only involves small jumps, meaning that no other jumps are needed to complete the level, even though all the other features are present. The second level introduces the bigger jump and finally the third level introduces the wall jump. As mentioned before both wall slide and wall jumps are out of the scope of this project, so only level one and level two are looked at.
At the start of the game the rhythm has set standard rhythm. For the first level the platforms are aligned such that the player can make all of them by starting the first jump moving from right to left. The platform starts halfway to make that jump easy to make. In the next pass the same happens, a single jump with much room for error. The next two passes will require two jumps, giving less time to make the jumps as well. This ends the first section, and as such the rhythm for this section. The second level is similar, the first pass has a single small jump, the second pass now has two small jumps followed by the final two passes that require a single big jump each. After these jumps a row of platforms is made, effectively protecting the player from falling down multiple sections. After this point the same rhythm is used, but with a slight adjustment, an `off-beat`. This off-beats is created to ensure that the sections are similar, but not the same. If the sections stayed the same the rhythm would be clear which is what we want, but it would most likely become boring as the jumps are perfectly predictable. The off-beat creates a small change of the rhythm, such that the only input from the player, the jump, is at a different pace. These changes are separated by the number of the level and the impact on the rhythm, small or big. Depending on the level, the options for the off-beat increases. The implemented small off-beat is changing the distance a jump makes before the character is supposed to land, that is the jump point and how long the button should be held stays the same, only the point the player lands, the jump distance, is different. Whilst this does not change the rhythm, it may confuse the player into thinking the jump point is different, with the intent of making the section feel new again. This change in distance should not make the landing point past the wall or the jump point of the next jump in case the pass has more than one jump. Another option for a small off-beat that is not implemented would be changing the height of the jump starting from level two. Here the point at which the player jumps stays the same, but the button has to be held for longer. The rhythm itself changes little, the intensity and jump moments stay the same, but enough that is keeps every section interesting. The bigger changes however affect the rhythm more.
The first big off-beat is moving the point at which the player should jump, which should make the jump only slightly harder to complete. It is not moved enough to be too confusing, but it does change the pace of the jumps within the rhythm. The second change and third change involve removing and adding jumps to the rhythm. Removing a jump is only possible if there is more than one jump on that pass, if there is only one jump, that pass will involve no jumps at all. In order to connect to the next pass this pass needs a filled in row of platform, which would be a bit too easy of a jump. In order to add a jump it is important that there is enough space for one. Both a small jump and a big jump can only end by going down. This means that the player can only land after it is at the peak of that jump. This makes up the minimum jump

distance required for that jump. Chose a pass and count the distance of all jumps together with a constant deviation to allow mistakes. If this minimum adds up to more than the width of the game, the jump cannot be added to this pass. After finding a pass that satisfies this criteria the jump point is decided and the jump plan comes into action. Now every time a new section is created the big off-beat is used to move the other jumps away such that, after a few sections the jump can be added without overlapping jumps. Finally a big change that might be interesting, but is not implemented, involves merging two jumps into a wall jump. By moving two jump towards the same wall, these two jumps can be merged without affecting the points at which the player has to jump too much. These changes should be big enough to be noticeable, but small enough that they rhythm still makes sense.

5.2 Experiment

In order to reason about the used PCG and rhythm an experiment was conducted. In this experiment the original game is compared with the modified game, as described in this project. The original game, that is, the game used by Squla, became the base for this new level generation, and uses a simple level placement system. For every level there exists a hand full number of hand made sections, that are randomly placed on top of each other. Instead of the original game, for this experiment the game lasts 1 minute instead of 30 seconds to give the players a better idea of the game. This leaves a lot of control to the developer, as all the platforms are in set locations, therefore no jump will be impossible and they can easily decide how many coins are available to the player for every section. However there is no consistency between levels, if the player is in level 2 it may get any section from level 1 and 2 at random. These levels have a lot of coins spread out, meaning that you cannot collect all coins without backtracking. The proposed version has platforms following a rhythm, only containing coins at the end of the jump, and making a single run through the levels is enough to collect all the coins making it different in several ways from the original.
For the experiment the participant will randomly start with the original or modified version of the game. After playing the game the participant will answer a few questions about their experience. After these question the same happens, now presented with the other version. Finally some general questions follow as well as questions comparing the two games. This entire questioner can be seen in Appendix B.
The questions about coins and height aim to discover if the participant was able to achieve their goal when playing the game. The original version should be more accommodating for players going for many coins, but the proposed modified version should be better for getting higher, as both the platform are more rhythmic and the coins can be collected by simply following it (and not needing to backtrack). If the player gets the experience that they, that is collecting coins or gaining as much height as possible, the game should be more enjoyable. For both games are some common questions includes. Wanting to play the game again is important as mentioned before regarding the reward, and asking about fun, whilst not clearly defined, is still a question that anyone can answer. Comparing both games is important to gauge if the modifications changed the experience.
The frustration and difficulty are probably the most important questions, the focus of the game is relaxation, so even if the game if enjoyable, it should not be frustrating. There are many games that are frustrating and get their "fun" from overcoming these challenges, the more impossible it looks, the better it feels when you finally get through it. However this is not the goal of the game, in practice the user has gone through several educational questions

already, so the game should provide some relaxation after all that work. Difficulty is closely related to this, but not the same. If the game seem difficult, but not frustrating, the difficulty is they want it which would relate to their sense of flow.
All the open questions are used to get reasons behind different choices. Why a version is difficult or frustrating can help improve the current versions and their experience may indicate what they want from the game.

6 Results

The experiment has yielded a total of 17 participants with various ages and experiences. The algorithm described in this project is intended as a trail of what can be used, so the focus of the results will be on discovering the strong and weak points for future work. For this experiment an automatic randomizer was used, 12 participants started with the modified version and 5 with the original version. A list of tables showing all the quantitative data can be seen in Appendix C. With an average of $2,3$ the original version has an advantage when comparing the two version by their experienced "fun". This is also reflected in the participants "willingness" to play the game again, the average for the original version is $3,2$ and a $2,6$ for the modified version, but it is not a big difference. The focus of the player, that is, collecting as many coins as possible or getting as high as possible, is not seen in the results. Players focusing on height did on average not get much higher than others. The same counts for the coins. Even when dividing the two, to get the fraction of both game elements, there is still no relation to their stated focus. Looking at the results there are arguments to consider some results outliers, however, given the small sample size this would become too big of a fraction and is therefore not considered. As mentioned before, the original game has more coins, whilst the modified version is created to make climber higher more satisfying by using a rhythm combined with the coins completely focused on that path. However there seems to be no relation between the focus of the player and their enjoyment towards a specific version. Unlike predicted, participants that wanted to get as high as possible do not enjoy the modified version more, nor do participants focusing on coins enjoy the original more in comparison. With an average of 3.4 the modified version seems to be more difficult than the original version, this is again not by a big difference as there are still some participants that found the original more difficult. Especially the second level of the modified version was difficult. In this level the player is required to hold the jump button for the entire duration which some participants failed to grasp in the given time. Participants found the modified version more difficult as the character could more easily drop down which, unlike the original, simple required the player to make the jumps again without getting coins making the game feel more punishing. The participants preferring the modified version mentioned that leaving behind coins in the original game felt frustrating. All participants that mentioned this were also experienced with games. Overall the original game was considered more fun and less frustrating as failing a jump would not make the player to much progress and even yielded some coins.

7 Conclusion

This project has used PCG and rhythm on a level generation system for a simple vertical climber game with only a single input, jump. Every level is separated in sections in which a rhythm like system is used to place down the platforms. The game is intended to be relaxing as

this is one of the rewards after going through a session of various educational games. Starting of with a set starting rhythm, the section gain random changes, also known as off-beats, making each section, and by effect every level, different. These changes are made such that a rhythm can be found between each section. The jumps are predictable to some extend, creating a rhythm like sensation, but with slight adjustments, that ensure each section is not the same as the others. This rhythm is intended to get the player in a flow state, creating some novelty while playing the game. The coins are used as a rewards whilst getting higher is required to move towards more coins, which can be seen as an achievement in its own way. In this project coins are used to guide the player where the player should land. They can also be used as compensation when falling or simply as decoration, which also happened in the original version. The results however are mostly inconclusive. The rhythm did create sensible levels, but as there was no fail-safe after falling making the levels more frustrating. The second level of this projects version especially was too difficult as the jump was too high. The only thing of note is that some of the frustration felt for the original version. Some players felt some frustration having to leave may coins behind when trying to get as high as possible. This was only pointed out by participants that play more games. A big limitation here is the target group, children between 8 and 12, as they will likely not have enough experience to have this "must collect it all" mindset. Whilst this is interesting this is not be useful for this specific application. Every session is about 30 seconds long, so any differences made should be applied quick enough that it is noticeable in that time, but not too much that the intended rhythm changes too quickly. For this project there were no "catching" platforms as the rhythm would become more convoluted, however looking at the results it is definitely worthwhile to try and integrate this as the main focus of this project, the relaxation, should insure that mistakes are not punished too much.

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A Substitution

$$y = \frac{-4hx^2}{d^2} + \frac{4hx}{d}$$

$$x^2\frac{-4h}{d^2} + x\frac{4h}{d} - y = 0$$

Note that for this formula we only need the negative side, the player cannot land before the prime of the jump;

$$x = \frac{-\frac{4h}{d} - \sqrt{(\frac{4h}{d})^2 - 4\frac{4h}{d^2}y}}{2\frac{-4h}{d^2}}$$

$$x = \frac{d^2}{-4h} * \frac{-\frac{4h}{d} - \sqrt{(\frac{4h}{d})^2 - 4\frac{4h}{d^2}y}}{2}$$

$$x = \frac{-4dh - d^2\sqrt{(\frac{4h}{d})^2 - 4\frac{4h}{d^2}y}}{-8h}$$

$$x = \frac{-4dh - d^2\sqrt{4^2\frac{h^2}{d^2} - 4^2\frac{h}{d^2}y}}{-8h}$$

$$x = \frac{-4dh - 4d^2\sqrt{\frac{h^2}{d^2} - \frac{h}{d^2}y}}{-8h}$$

$$x = \frac{dh + d^2\sqrt{\frac{h^2}{d^2} - \frac{h}{d^2}y}}{2h}$$
$$x = \frac{dh + d^2\sqrt{\frac{h^2}{d^2} - \frac{h^2}{d^2}\frac{y}{h}}}{2h}$$
$$x = \frac{dh + \frac{h}{d}d^2\sqrt{1 - \frac{y}{h}}}{2h}$$
$$x = \frac{d + d\sqrt{1 - \frac{y}{h}}}{2}$$
$$x = \frac{d(1 + \sqrt{1 - \frac{y}{h}})}{2}$$

B Questioner

The participant played either the original or the modified version.

1. How many coins did you collect in the first level of the first game? (open)
2. What height did you reach in the first level of the first game? (open)
3. How many coins did you collect in the second level of the first game? (open)
4. What height did you reach in the second level of the first game? (open)
5. Would you like to play this game again? (1 to 5, unlikely to likely)

The participant played the other game now.

1. How many coins did you collect in the first level of the second game? (open)
2. What height did you reach in the first level of the second game? (open)
3. How many coins did you collect in the second level of the second game? (open)
4. What height did you reach in the second level of the second game? (open)
5. Would you like to play this game again? (1 to 5, unlikely to likely)

The general questions.

1. Which of the two games did you find the most fun? (1 to 5, first to second game)
2. Which of the two games was more difficult? (1 to 5, first to second game)
3. What made this game more difficult? (open)
4. Which of the two game was more frustrating? (1 to 5, first to second game)
5. What made it frustrating? (open)
6. Do you play any games in your own time, if so what kind? (open)
7. Overall, where did you focus on, getting as high as possible or getting as many coins as possible? (1 to 5, coins to height)
8. Do you have anything else you would like to add?

C Results

Note that in all cases the first 5 results are stated with the original version and the remaining 12 started with the modified version.

Original First Level	Original Second Level	Modified First Level	Modified Second Level
36	56	30	32
8	26	9	25
40	23	5	8
8	12	13	6
38	35	46	6
76	49	52	21
22	16	21	3
36	33	26	36
54	32	21	3
26	45	30	4
39	75	34	37
27	44	42	37
60	66	43	28
29	9	17	3
21	56	24	17
26	46	30	26
56	39	29	13

Table 1: The collected coins for the various levels

Original First Level	Original Second Level	Modified First Level	Modified Second Level
51	81	55	78
24	49	18	58
89	40	9	17
21	26	24	15
36	47	82	16
111	103	99	65
44	32	49	8
79	76	48	83
59	50	40	8
48	55	57	10
67	54	66	88
75	74	77	87
99	84	80	75
55	26	31	9
63	46	50	38
67	58	57	65
81	94	55	36

Table 2: The achieved height for the various levels

Original, play again?	Modified, play again?	Comparison of fun O-M
3	4	2
1	2	1
1	1	5
2	3	2
3	4	2
3	5	2
1	1	1
5	4	4
3	3	2
2	4	1
2	2	3
5	5	1
4	3	4
4	5	1
5	5	4
1	1	2
4	4	2

Table 3: The questions asking about enjoyment. Note that if the modified version was shown first, the comparison is reversed ($6 - x$ as the scale goes from 5 to 1)

Difficulty O-M	Frustrating O-M	Focus Coins-Height
1	2	3
1	1	5
4	4	3
2	2	4
5	1	2
5	3	1
5	5	4
2	4	2
1	1	1
2	2	2
4	3	4
3	2	4
2	4	2
5	5	3
5	5	5
5	4	2
2	4	5

Table 4: The remaining quantitative data, that is, the experienced difficulty, frustration and focus.