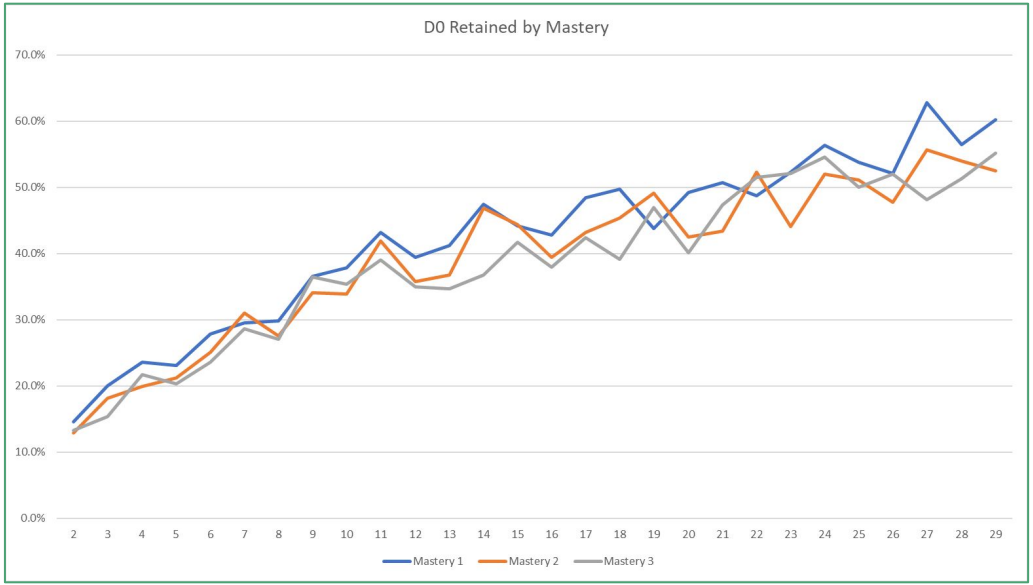
Adaptive Tuning

Crossword Explorer

Opportunity

- On D0, the average D1 retention of users leaving the game at mastery 2 & 3 is at 34.7%
- For mastery 1 users, the average retention is around 36.1%.
- Between nodes 10-20, the retention for mastery 3 users is lower by around 500 bps w.r.t mastery 1.



x-axis: last node played by the user
y-axis: % of user retained

Problem Statement

1. From the opportunity slides we can conclude,
    a. Mastery 1 player's have better D1 IR than mastery 2 and mastery 3 players.
    b. As a result there is an opportunity to get better retention metrics from players with mastery 2 and 3.
2. From player reviews
    a. We get a lot reviews from players stating about how the early crosswords are super easy and as a result we lose those players.
    b. So there is need from the players indirectly.

EO

Adaptive Difficulty				
	Current	**New**	**%Change**	**Comments**
D1 Install Retention	28.30%	29.40%	110 bps	By closing the gap in retention for mastery 2 & 3 users.
D7 Install Retention	12.20%	12.67%	47 bps	Having similar decay as control
LT Days	13.573	14.100	3.89%	
Rev per DAU	$0.258	$0.255	-1.00%	Drop in rev per dau from lower engaggement due to harder puzzles.
LTV	$3.50	$3.60	2.85%	

Objectives

1. To offer higher mastery players, harder game content so as to match their skill set and keep them interested in playing the game.
2. To increase D1 IR by 110 bps which will subsequently increase out LT days. Leading to an LTV increase of 2.85%.

Vision/Anti Vision

Vision:

1. I like that i able to play the harder challenging puzzles at an earlier stage of the game.
2. I find the puzzles hard and challenging, it makes me think and spend time on solving more puzzles.
3. I like that the game recognizes my skill and gives me the opportunity to play the puzzles that account to my skill set.

Anti VIsion:

1. I find this game too easy/hard and as a result boring/frustrating to play the puzzles.
2. I do not like that i cannot revert my changes on the game’s difficulty.

The Pathways

1. In order for us to solve and gain best of the opportunity we have presented, we will try out two ways to approach this for now,
    a. Content Jump Method
    b. Adaptive Flow
2. We will look at them individually and then to the pros and cons section, followed by a pitch for v2 where both ideas seamlessly combine.

Adaptive Flow

Experimentation Details

1. Adaptive Flow
    a. Using the existing adaptive experimentation
    b. Experiment Name : adaptive_content
        i. Var 2: current ramped up version
        ii. Var 1: use the same setup as var 2 with adaptive clues for puzzle 1-30

Feature Brief - Adaptive Flow

1. On a high level,
    a. Similar to the previous method we will first calculate the player's mastery from the early puzzles.
    b. So for players who are highly skilled (i.e mastery > 2) we will change the clues for the player.
    c. These clues will be harder and force players to think more often and possibly use hints.
    d. The core logic of the adaptive difficulty will not change, just the clues we will match it with will be different harder list.

Feature Details - Adaptive Difficulty Flow

1. This flow will be applicable for players in var1 of adaptive difficulty experiment.
2. Existing Adaptive Logic
    a. There will be no change on the direct workings of Adaptive clue difficulty logic.
        i. We will calculate the avg mastery for the player after 3 puzzles <puzzleRequired_adaptive>, by default the player will be put in bucket 1.
        ii. The new adaptive content (new clues) will be reflected on the 2nd puzzle onward <adaptive_start> based on the average mastery and will be reflected on the puzzle. (to check if adaptive can start before average mastery puzzles.)
        iii. The number of clues to be changed will remain the same for each bucket and puzzle size.
        iv. Refer to this spec's for the adaptive working.
3. What's different?
    a. It's the clue matching that will be different for the first 30 puzzles. Instead of changing the clues from the existing list. We will use a different set of clues which will be significantly more harder on the difficulty scale.
    b. Early starting of the adaptive flow. (used to start from node 26)

Feature Details - Adaptive Difficulty Flow (Changes)

	Control	Variant	Comments
Adaptive Start	26	2	To check if adaptive can start before mastery puzzles
Adaptive Bucket	2.2_2.9	2.2_2.9	Not changing this as this will impact adaptive post lvl 30
5x5 Bucket 1 Words	0	0	
5x5 Bucket 2 Words	1	1	
5x5 Bucket 3 Words	2	2	
Mastery Puzzles	3	3	

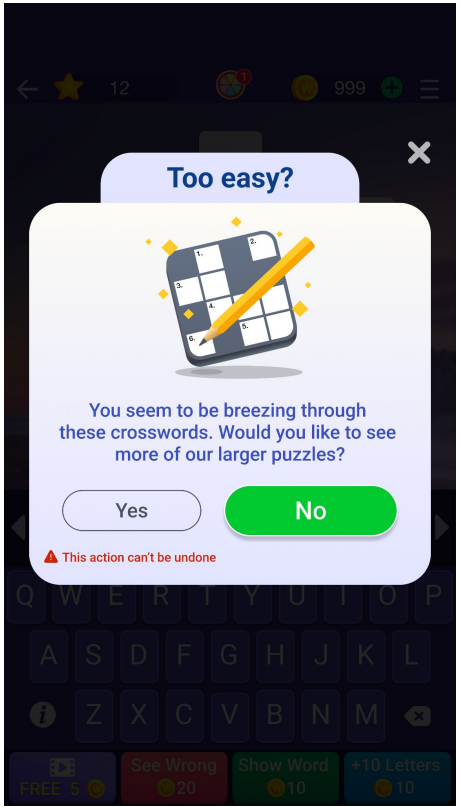
Content Skip

Experimentation Details

1. Content Skip
    a. New Server Controlled Experiment : content_skip
        i. Control : existing node curve
        ii. Var 1: based on player mastery & feedback, content jump to adjust the difficulty
        iii. The experiment will only be available for new installs.

Feature Brief - Content Jump

1. To explain this method on a high level,
    a. After the first FTUE puzzles, which are the first 4 levels.
    b. We will calculate the mastery or some method to determine the player's exact skill and if its higher.
    c. A popup will trigger,
        i. If the players tap on Yes we will move them to a higher node content. This means that the players will still remain on node number 6 but the crossword is of a much higher node number.
        ii. If the players tap on No the content will remain same and they will continue with the normal level progression.
    d. The popup will mention that the process is one directional that is once you tap on yes there is no going back.
    e. This feature itself will not work for features with lookahead flows or the features that use lookahead logic. As a result the popup will not be surfaced for these players.

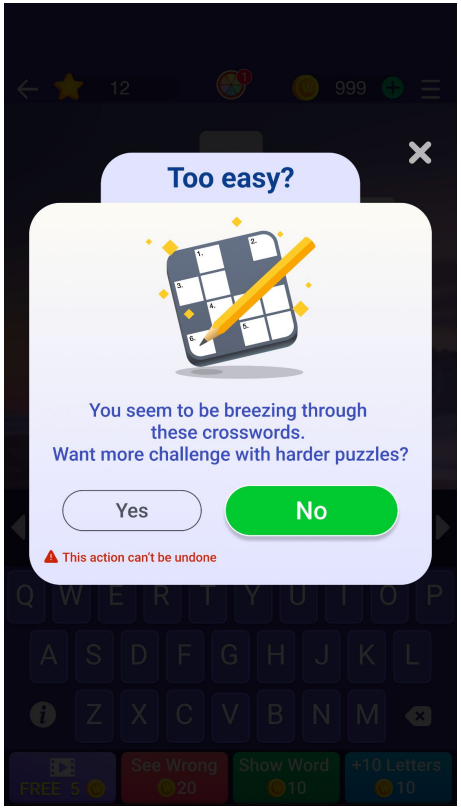


Feature Details - Content Jump

1. On the puzzle outro view of node 4, the players with avg mastery greater than <contentMastery> (runtime, planned value 2.3) will view a feedback popup about the difficulty of the crossword puzzle.
    a. Not node 6 because there is a spike in drop-off users post country complete on node 5.
2. The popup will have two CTA buttons.
    a. The primary CTA will keep the same content curve for the players.
    b. The secondary CTA will change the content of players to an advance curve.
3. The popup will have a small text below secondary CTA conveying that this action cannot be reversed.

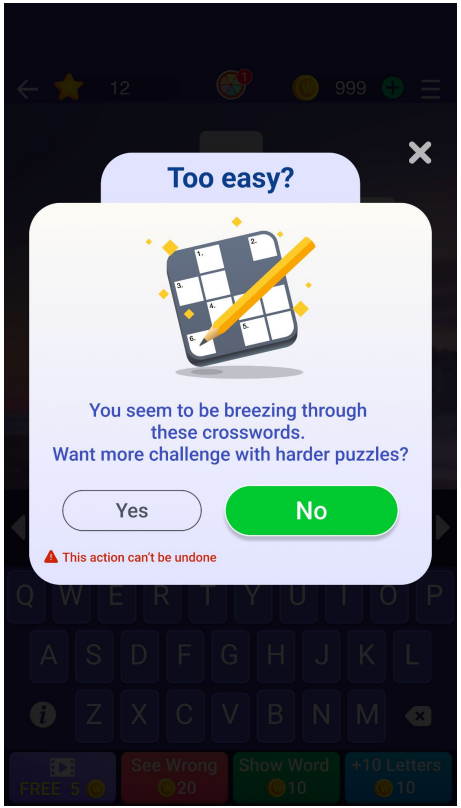
Feature Details - Feedback Popup

1. This will be the popup that will trigger for players to initiate a content jump.
2. The main CTA will be “No”:
    a. This would be the players who tap on this CTA will not get any change on their node puzzles.
3. The secondary CTA will be “Yes” :
    a. Tapping on this players will get bigger puzzles.
4. Under the Crossword Icon
    a. The main subtext will mention that the players can get harder content.



Feature Details - Review Screen

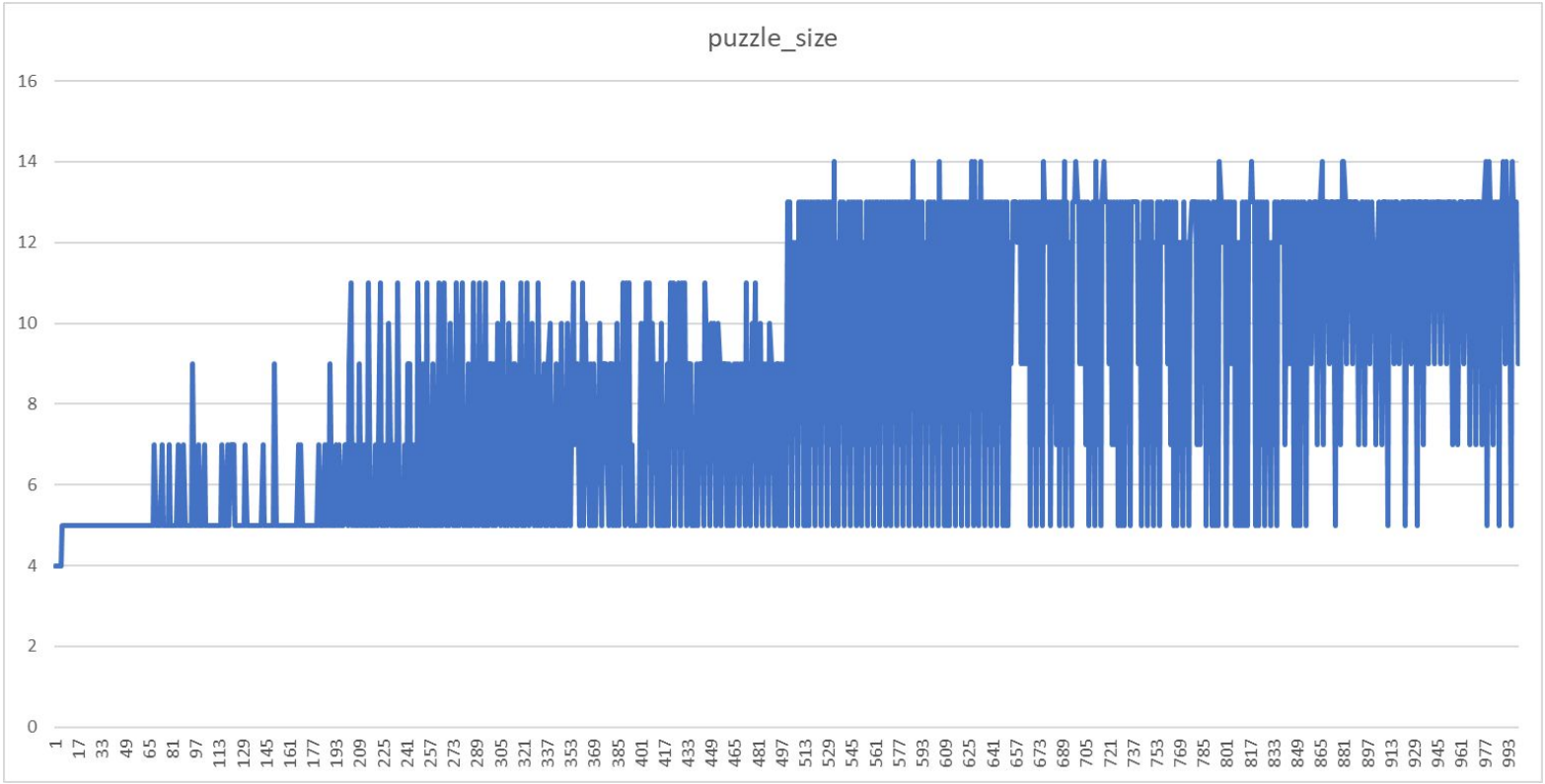
1. Priority :
    a. This popup will have the highest priority on the review screen.
    b. Added this feature to the list on the sheet.
2. Outro Icon Flow handling :
    a. If the player taps on piggy icon, weekly fest icon or rocket rush icon and returns to the review screen the player will not see the popup.
    b. There will be no resurfacing of this popup.



Feature Details - Secondary CTA Flow

1. If the player's mastery is > 2.3 <contentMastery1> and the player taps on the secondary CTA on the feedback popup, they will get the content from node 195 (on node 5).
    a. Node 195 to keep the progression relevant (as there are many puzzles with sizes 5 , 7 , 9 and 11 around node 200 and as the player will progress towards node 300, they will have higher number of 13 size puzzles.)
2. If the player's mastery is > <contentMastery2> and the player taps on the secondary CTA on the feedback popup, they will get the content from node 75 (on node 5)
    a. This is done so that players of different skills are offered the content within their range of puzzles.
3. If the runtime values for <contentMaster1> & <contentMastery2> are -1, we will stop the flow entirely. There will be the case for when one of the runtimes is -1 while the other is not, in these cases the player's are eligible for the respective feedback flow.
4. The skipped nodes (5-194 or 5-74) will be added post current EOC content.
5. EOC content added in future will be added after the last available node for all the users.
    a. If the users skipped the initial puzzles, the last available node will be after the skipped nodes.

Feature Details - Current XP Content Curve - by Puzzle Size



Feature Details - Other Flows for Skipped Content

1. Country Complete
    a. The countries will have the same node as starting and ending point. (only the content will change)
2. FTUE & Feature Unlock will be done at the same nodes.
3. Ads Unlock :
    a. Banner: at node 4
    b. IT : at node 16, keeping it same for now to have less variables
4. ~~FB Sync :~~
    a. ~~The flow will be same. For players with skipped content, the actual node (195+) will be considered for the fb sync.~~
    b. ~~Ex: if user does the FB sync, the nodes that will be considered for restore will be the actual node+ skipped node.~~
        i. ~~If user played through node 10 and had a progress of 160 on fb. Then the node 10 progress will stay as 10+195>160.~~

FB Sync Cases

Conditions : the actual node number will be compared and the higher actual node progress will be restored on the device.

The skip value will be stored on the server and if the build is compatible to take the skip value then skip value will be synced as well.

(In the cases, new build would be the builds with skip value compatibility and old build will be without skip value compatibility)

FB Sync : New Build to Old Build

- Before EOC :

New Build
Current Node : 250
Skip Node : 100 at 10
Net Node : 350
EOC : 500

Old Build
Current Node : 210
Skip Node : 0
Net Node : 210
EOC : 500

Here, during the sync on old build, the progress of new build will be restored as the value of current node is higher than the old build build current node.
The content at node 250 will be different on both the build as on the new build content will be from the skipped node and on the old build will be the content of actual node.

- After EOC :

New Build
Current Node : 420
Skip Node : 100 at 10
Net Node : 520
EOC : 500

Old Build
Current Node : 210
Skip Node : 0
Net Node : 210
EOC : 500

Here, during the sync on old build, the progress of new build will be restored as the value of current node is higher than the old build build current node.
On the old build, the player will have to repeat the last 80 puzzles before EOC.

P.S. If the old build node is higher in both the cases, the progress sync will happen normally but the players might have to repeat some nodes due to skip on new build.

FB Sync : New Build to New Build (Same skip value)

- Before EOC :

New Build 1
Current Node : 250
Skip Node : 100 at 10
Net Node : 350
EOC : 500

New Build 2
Current Node : 210
Skip Node : 100 at 10
Net Node : 310
EOC : 500

Here the sync will happen normally based on higher current node value.
The progress of new build 1 will be restored on new build 2.

- After EOC :

New Build 1
Current Node : 420
Skip Node : 100 at 10
Net Node : 520
EOC : 500

New Build 2
Current Node : 450
Skip Node : 100 at 10
Net Node : 550
EOC : 500

Here the sync will happen normally based on higher current node value.
The progress of new build 2 will be restored on new build 1.

FB Sync : New Build to New Build (Diff skip value)

- Before EOC (higher skip at higher progress) :

New Build 1
Current Node : 250
Skip Node : 100 at 10
Net Node : 350
EOC : 500

New Build 2
Current Node : 210
Skip Node : 50 at 10
Net Node : 260
EOC : 500

Here, as the net node will always be higher so the sync won't have any repeat puzzles.

- Before EOC (lower skip at higher progress) :

New Build 1
Current Node : 425
Skip Node : 100 at 10
Net Node : 525
EOC : 500

New Build 2
Current Node : 430
Skip Node : 50 at 10
Net Node : 480
EOC : 500

As the current node on new build 2 is higher, the progress of new build 2 will be synced and the player have to play the repeat puzzles for 45 puzzles on new build 1. (difference of net nodes)

FB Sync : New Build to New Build (Diff skip value)

- After EOC (higher skip at higher progress) :

New Build 1
Current Node : 475
Skip Node : 100 at 10
Net Node : 575
EOC : 500

New Build 2
Current Node : 460
Skip Node : 50 at 10
Net Node : 510
EOC : 500

Here, as the net node will always be higher so the sync won't have any repeat puzzles.

- After EOC (lower skip at higher progress) :

New Build 1
Current Node : 460
Skip Node : 100 at 10
Net Node : 560
EOC : 500

New Build 2
Current Node : 470
Skip Node : 50 at 10
Net Node : 520
EOC : 500

As the current node on new build 2 is higher, the progress of new build 2 will be synced and the player have to play the repeat puzzles for 30 puzzles on new build 1. Max repeat puzzles will be the difference in skip values.

Runtimes

Runtimes

1. contentMastery1 : mastery for showing the feedback popup to jump to node 195
2. contentMastery2 : mastery for showing the feedback popup to jump to node 75
3. If user is eligible for both, contentMastery1 will have higher priority to show the popup.

Edge Cases

Edge Cases

1. For all kill relaunch cases, the popup should not resurface for the players on the review screen.
2. If the player was on control and switches to variant, now if the player clears the eligibility criteria for the content skip popup it should surface on the review screen. The popup should not appear if the eligibility conditions fail.
3. Similarly if the player was on variant and taps yes for the context skip and then moves to control. For this case the content of the player will remain as is and there will be no reverting back to the original content.

Change Log

Change Log

1. 06-07-2024
    a. Added Edge case slide.
    b. Updated runtimes slide with point 2, slide.
    c. Updated point 4, FB sync case on slide.
    d. Added point 1e, slide.
    e. Added point 1aii, slide.
    f. Added review screen handling slide.

Pitch for V2

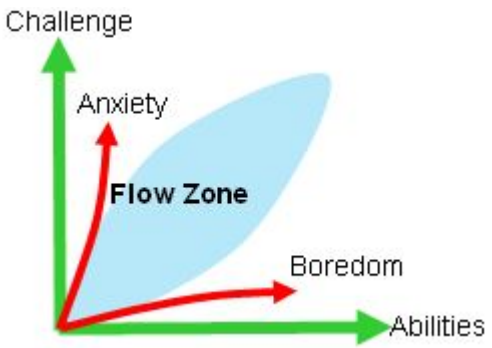
Pros & Cons - Content Jump vs Adaptive Difficulty

Content Jump	Adaptive Difficulty
This method will not require content effort as we are just jumping the content to higher node. (Depending on the way we plan to implement)	Adaptive difficulty will required curated clues so that we can make things harder for the players who require so.
The funnel data analysis will become individual for each player. Making it harder to understand behaviour in when looking at funnel data.	The core gameplay of progressive getting bigger puzzles is kept intact, it's just the behaviour of each crossword will be different.
Considering the way we are implementing this is that this method will be a irreversible, one directional in nature. Meaning if a player wants to revert back the change they cannot.	A much more dynamic method and can change based on the player’s behaviour

DDA

Dynamic Difficulty Adjustment

1. DDA is a very important term in games design, being the core element for many games across the industry.
2. There is no need for a direct introduction for this topic, since by definition its basically what adaptive difficulty refers to itself.
3. The core reason to change the difficulty is to keep the player's in the state of flow. Once a player breaks the flow, they either get frustrated or bored. In our case we get many tickets/reviews of players stating our early crosswords are too easy and as a result they get bored.
4. Basically to conclude, flow adjustment is basically resultant of DDA.



Dynamic Difficulty Adjustment

1. Based on Jenova Chen’s Flow in Games thesis we know we have two major approaches to DDA
    a. Passive Flow Adjustment
    b. Active Flow Adjustment
2. We will get into each method and how we can implement the same with respect to our game. Making sure to follow each specific model.
3. Let's start with Passive Flow adjustment, how it fits in our game and then to understanding why Active flow adjustment is just better.

Passive Flow Adjustment

1. The four main fundamentals for the loop consists of:
    a. Player : Record/Create raw data from the player playing the game.
    b. Monitor System : Choose the data that defines the player's flow state and pass it to the analysis system.
    c. Analysis System: Analyze the player's flow state and update the game system accordingly.
    d. Game System : Apply the changes and change the player's experience for the player.
2. Theoretically, this system will constantly check for the player's flow and adjust the gameplay accordingly. Let's now look at how the system applies to our game's Adaptive clues.

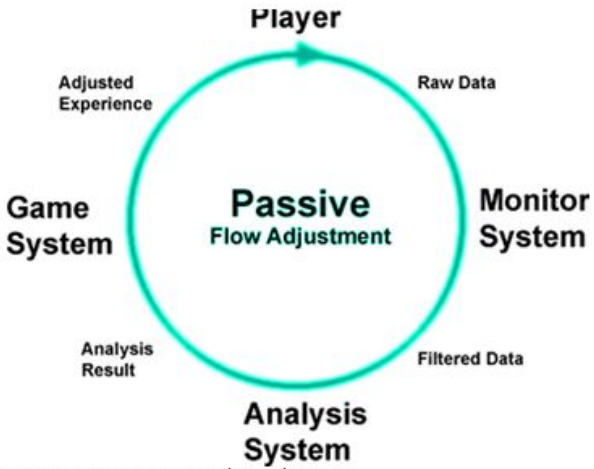


Figure 5 System-oriented DDA loop

Passive Flow Adjustment in XP

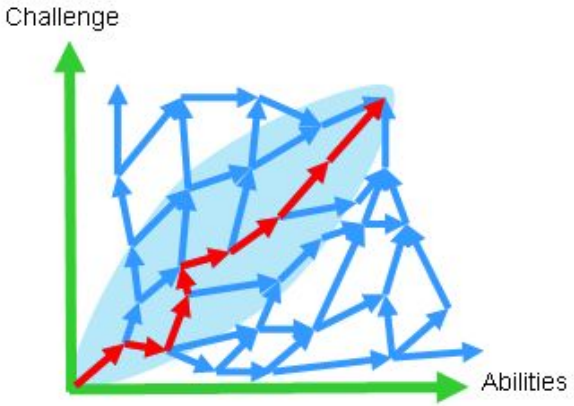
1. Going from the previous slide, looking at XP's Adaptive Clue implementation. Lets phase them into the same four fundamentals:
    a. Player's average mastery is recorded for the first n puzzles.
    b. Monitor player's avg mastery from n puzzles and update the player's bucket from n+1 puzzle.
    c. Analyze the player's bucket and how much changes needs to be made on the gameplay.
    d. Update the puzzle's clues based on the bucket's puzzle size requirements.
2. We will now look at why Passive flow adjustment though is proven to work nicely on most games. This design overlooks one major aspect of flow theory that not many games takes into account.

Problems with Passive Flow Adjustment

1. No direct data:
    a. Video games do not read the player's mind, no matter much data we pull from the game's interaction something as psychological as Flow theory needs direct access to the player's mind.
2. Performance does not reflect the flow:
    a. Let's take XP's example, we record the player's avg mastery which in game design is referred to as a Game performance metric. This performance metric, is objective in nature but flow itself is subjective. For example, if a player is reading through clues and knows the answers for all of them but chooses to only enter the answers when they have it all figured it out. For this player this is how they are in flow, but from the perspective of performance metric is will categorize the player as a lower skilled player.
3. Analysis based on assumptions:
    a. Continuing from the previous point, assumptions will never work on a mass audience. We cannot assume that a player who takes their sweet time completing a puzzle is a lower skilled player.
4. Changes are based on a rigid design:
    a. The way the system in our game is changed is pre-determined by the person designing it. This means for every individual we will have different ways to determine the change in the game system. Once again coming back to the point of that assumptions will not lead to the better player experience.

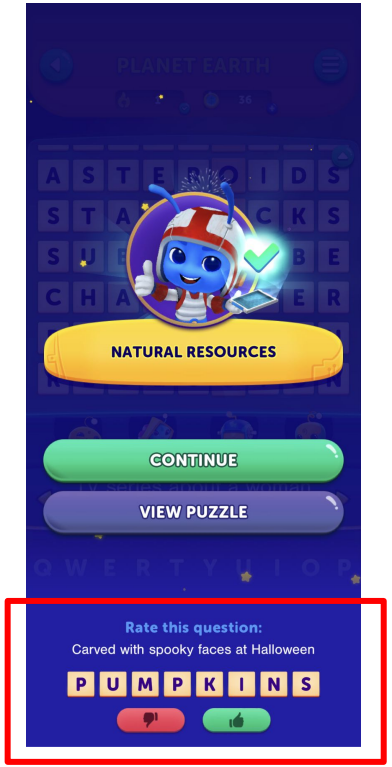
Active Flow Adjustment

1. Now to get into active flow adjustment, based on Chen's thesis he states that the system oriented DDA focuses too much on balancing the challenge & ability but misses to take into account of a major point about flow theory which is for the player to feel a sense of control.
2. The choices that the player is presented with needs to be frequent but not frequent enough to interrupt their flow, the choice needs to be part of the player's flow. Basically let the player treat the choices part of the play and eventually ignore them.
3. Now how do we implement this on XP? Well let's take an example of some features of Cody cross. Namely the "Rate this question" feature.



Possible Implementation

1. Cody's feature practically does not work the way we could potentially implement them as but theoretically it uses the core elements of Flow in Games.
2. The Rate feature :
    a. Takes player choice very frequently without interrupting the play.
    b. Takes player input for their core gameplay experience.
3. On XP, we could do a similar surfacing on the review screen but instead of asking GK questions, we could ask for a feedback on how their puzzle was and give two options to rate them. The framing of the question should be similar to the lines of the content jump popup. Basically we ask if the puzzle was hard or not.
4. If the player finds it hard we will tune the adaptive difficulty to give the player easier clues. Similarly for the other option.



Checking for Player's General Knowledge

Conclusions

1. In order to bring active flow adjustment and make sure players are always looped into playing our game we would need to ideally create a feature that helps tie the existing system and the principles of active flow adjustment into a single unit.

Content Skip Resurfacing

Experiment Details

1. Server Controlled Experiment : content_skip
    a. Control : existing node curve
    b. Var 1: based on player mastery & feedback, content jump to adjust the difficulty
    c. Var2: Will have new content skip popup resurfacing & logic for jump value.
    d. Var3 : Copy of var2 with different runtimes
2. The experiment will only be available for new installs.

Feature Brief

1. We will be introducing a new variant in the current content skip experiment.
2. The variant will introduce a resurfacing logic for the players who tap on “No”/Close Button clickers on the content skip popup and for players who have not seen the first content skip popup on node 4 due to their eligibility.
3. We will not create multiple instances of jumping through nodes, the value of the jump will always be constant.
4. This existing edge case handlings & handling for EOC will remain the same even in this variant.

Feature Details - Resurfacing Logic

1. The flow of the popup will remain the same.
2. We will be updating the priority of the popup for content skip.
3. The logic check for the eligibility amongst players will be based on the <contentMastery1_contentMastery2> & <NodesSkipped1_NodesSkipped2> runtimes.
4. The resurfacing will happen only if the player has not initiated a jump,
    a. We will introduce a new runtime <content_skip_nodes> [will also include the first view of the popup] for the puzzles where the popup should resurface. This will also include the first view of the content skip popup.
    b. <content_skip_nodes> is a collection of puzzles where the surfacings of the content skip popup should appear, the end limit of this string is node level 74.
    c. Variant change check, will need to be updated. Now if a variant change happens players are eligible for the popup.
5. In addition to this we will be removing the lookahead logic for the popup.

Feature Details - Jumping

1. ~~We will want to maintain the difference of the jumping the same/constant, especially in the cases of resurfacings.~~
2. The nodes to be jumped will be controlled by runtimes NodesSkipped1 & NodesSkipped2 - to be used if player's mastery >= contentMastery1 and player's mastery >= contentMastery2 respectively
3. For example, if the popup surfaced for the player at 14th puzzle and the player tapped on Yes to initiate the content skip. On the 15th puzzle their puzzle to be jumped to will be,
    a. 70 + 15 = 85th Node is where the new reference should be for the player. (First Jump Difference + Current Node)
    b. The same will also be applicable for when the player is eligible for contentMaster1 runtime (195th node jumping). Considering the same above example, the calculation for the same will be 190 + 15 = 205th Node should be the node where the player's puzzle content should reference to.

Runtimes

content_skip_resurfacing			
Runtime Name	**var2**	**var3**	**comments**
popup_surfacing_max_cap	3	3	The max number of times the popup can be resurfaced in lifetime. This will include the first time surfacing on node 4 as well.
content_skip_nodes	4_14_44	4_14_34	The values can be expandable and the max node surfacing will be capped at 74 hardcodedly
mastery_puzzle	5	5	The last 5 puzzles mastery from resurfacing node will be considered when looking for the eligibility of all popup surfacing
contentMastery1_contentMastery2	2.6_2.2	2.6_2.2	If player's mastery > contentMastery1 -> NodesSkipped1 should be used and If player's mastery > contentMastery2 -> NodesSkipped2 should be used '-1' is used in contentMastery runtime value then skip the runtime values and check follwoing mastery check. If all values are -1 then no surfacing will take place.
NodesSkipped1_NodesSkipped2	190_70	190_70	

Runtimes

Note:

- The mastery calculation to be used for the surfacing of the popup will take only last 'X' puzzles [Runtime: mastery_puzzles] into consideration for resurfacing. The puzzles to be considered can be any crossword puzzles (Node, DP, Themed)
    - For example: If the content skip popup resurfacing to happen on node 14 and mastery_puzzles is '5' then it should consider any last 5 recent puzzles avg mastery for eligibility.

Appendix

Adaptive Difficulty Flow

1. This flow will be applicable for players in var1 of adaptive difficulty experiment.
2. Logic
    a. There will be no change on the direct workings of Adaptive clue difficulty logic.
        i. We will calculate the avg mastery for the player after 3 puzzles <runtime>, by default the player will be put in bucket 1.
        ii. The new adaptive content (new clues) will be reflected on the 4th puzzle onward <runtime + 1> will be reflected on the puzzle.
        iii. The number of clues to be changed will remain the same for each bucket and puzzle size.
        iv. Refer to this spec's slides for more info on the specific number of clues and their location for each puzzle size.
3. What's different?
    a. It's the clue matching that will be different for the first 30 puzzles. Instead of changing the clues from the existing list. We will use a different set of clues which will be significantly more harder on the difficulty scale.
4. After node 30 case
    a. Once the player is done with 30 nodes, for now they will revert to back to the old list and the logic will continue be checked accordingly.

Feedback Popup

- Main Text : “Do you think these crosswords are easy for you?”
  - Intent: asking the user about gameplay and to check if the user is happy with the difficulty of first few easy puzzles. But it should also have a sense that this cannot be reversed.
- Primary CTA with green highlight : “These are perfect”
  - Intent: no issue with the content and player is liking the flow
- Secondary CTA without highlight : “Need harder crosswords”
  - Intent: the crossword is very easy for the user and the user need more challenge
- With a ⚠️ sign, there will be a smaller text below secondary CTA conveying the action cannot be reversed or it is a one time action.

Final Copy Texts:

Feature Details - Resurfacing Logic

1. The flow & priority of the popup will remain the same.
2. The logic check for the eligibility amongst players will be based on the existing runtimes.
3. We will introduce a new runtime for the puzzles where the popup should resurface.
4. The max value for this will also be 74.
5. Eligibility
    a. Players who tapped “No” or tapped on Cross button on the first view of their popup:
        i. The resurfacing of this popup will happen for every Xth puzzle. Based on the runtime, <content_skip_nodes>
        ii. The max value of this resurfacing is based on the <popup_resurfacing_max_cap> runtime.
    b. Players who have gone past lvl 4 and couldn’t reach the required mastery for the initial surfacing of the popup :
        i. The popup will follow a similar runtime (mentioned in the above point) check for the exact puzzle it should surface.