THE IMPACT OF DYNAMIC GAME DIFFICULTY BALANCING ON PLAYER USER EXPERIENCE IN PUZZLE GAMES

A case study

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Qian Lin

Supervisor: Mikael Johannesson
Examiner: Henrik Engström
Abstract

This study delves into the relationship between Dynamic Game Difficulty Balance and Game User Experience in the context of puzzle games. The aim of this study was to explore the impact of DGDB on user experience in puzzle games, focusing on player engagement, immersion, and the occurrence of a-ha moment. To this end, the researchers conducted a control group experiment and analyzed the results both quantitatively and qualitatively based on participants’ objective data during the game and subjective responses in the post-game questionnaire. The findings suggest that DGDB has the potential to increase player engagement and satisfaction, but the impact is modest, as evidenced by higher completion rates and flow channels in puzzle games. We explored the impact of the DGDB system on a-ha moment and the results were mixed. However, it is clear that the relationship between DGDB and puzzles is a delicate one, with players’ preferences and perceptions varying.

Keywords: Dynamic game difficulty balancing, game user experience, flow, puzzle games. Eureka effect, a-ha moment, engagement, immersion,
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1 Introduction

Over the years, the landscape of video game design has changed dramatically, with an increased emphasis on Game User Experience (GUX). GUX, defined by Nacke et al. (2009), centers around the experience players go through during gameplay. It plays a key role in game development, especially as game genres and game experiences become increasingly diverse (McAllister & White, 2015).

An important aspect of GUX is Dynamic Game Difficulty Balancing (DGDB), a system that adjusts game parameters in real time based on player performance (Andrade et al., 2006). The main goal of DGDB is to keep the player’s interest by providing an appropriate level of challenge and preventing the player from feeling overwhelmed or bored during gameplay (Zohaib, 2018).

However, adding a DGDB system to a puzzle game presents unique challenges. This study examines how the DGDB systems in puzzle games affect players’ game user experience, focusing on engagement, immersion, and the aha moment among participants.

Puzzle games require players to have critical thinking and problem-solving skills and are therefore becoming increasingly popular, especially in mobile games (Chi, Agama & Prodanoff, 2017). Researchers have identified design principles that contribute to their success, including clear objectives, feedback, and gradually increasing difficulty (Linehan et al., 2014). These games have also been used in education to improve cognitive skills, memory, and spatial reasoning (Reynaldo et al., 2021).

The current study seeks to bridge the gap between DGDB and puzzle games, revealing how the implementation of a DGDB system affects the player experience in this genre. Understanding how DGDB balances challenge and expertise in puzzle games explores the distribution of flow channels (Csikszentmihalyi, 2000) and the emergence of aha moments. In order to achieve this goal, we employ a comprehensive experimental approach that yields some insights into the impact of DGDB on the player’s experience in puzzle games.
2 Background

2.1 Game user experience (GUX)

According to Nacke et al. (2009) GUX is concerned with the experience that users generate when playing games. As games have evolved and different types of games have emerged, GUX has become a more important part of the game development process. But there are more variables in the game world, and GUX is an important part of the design (McAllister & White, 2015).

Researchers have used player data and analytics to improve GUX in a very used way as well. They collect and analyze data on player game behavior and preferences to improve game design and user experience. Many researchers have focused on developing methods for analyzing player data, such as machine learning techniques and applying these methods to game design (Göbel et al., 2014). They have developed a framework that uses machine learning to personalize game content based on a player's gaming behavior and preferences, thereby enhancing the player's gaming experience and motivation.

Researchers have also developed and studied various programs and techniques to help improve GUX. Including user experiences design programs such as wireframes and software related to game prototyping, as well as game analytics programs that allow developers to track player game behavior and engagement. For example, Sweetser and Wyeth (2005) developed a model for assessing the user experience of gamers GameFlow, which provided a deeper understanding of the enjoyment of two real-time strategy games and successfully differentiated between highly rated and lowly rated games. In addition, follow various design principles and best practices that developers can follow to improve the GUX, such as minimizing game load times, providing clear and concise game instructions, and correcting game difficulty balance (Deterding et al., 2011; Hunicke et al., 2004).

2.1.1 Dynamic game difficulty balancing (DGDB)

DGDB is a system (Andrade et al., 2006) that refers to automatically adjusting parameters, scenarios, and behaviors in a video game based on the real-time performance capabilities of the player. A study (Zohaib, 2018) showed that with a DGDB system in a video game, players do not feel bored or disengaged when the game is very easy, and they do not feel frustrated or want to give up the game when the game is very difficult. The purpose of DGDB is to keep the player’s interest throughout the game and provide a moderate level of challenge.

The DGDB system essentially changes certain parameters in the game in order to avoid negative emotions such as boredom and frustration in the player (Stein et al., 2018). A study (Andrew et al., 2020) suggested that player satisfaction in video games seems to be influenced by the difficulty balance of the game, i.e., the difficulty of the game challenges faced by the player.

According to Andrade et al. (2006), DGDB programs must be designed to meet at least three basic requirements. First, the game must be able to automatically recognize the player’s skill and adaptability, given that each player starts at a different level and progresses from novice to expert in very different times. Second, the game must pay attention to and track player behavior and changes as much as possible. Third, any framing that occurs during the course
of the DGDB system must be believable, as players do not want to feel that they are being pushed to complete the game, which defeats the purpose of the DGDB system design.

Vicencio, Mandryk and Gutwin (2015) proposed that implementing a dynamic difficulty system can alleviate the frustration often associated with getting stuck on challenging puzzles for long periods of time. DGDB system automatically adjusts difficulty levels, saving developers significant time and resources. Volz, Rudolph and Naujoks (2016) states that by using DGDB system, developers can concentrate on other aspects of game development, such as creating a captivating storyline, designing visually appealing graphics, or fine-tuning game mechanics. In addition to reducing development time and costs, DGDB system (Huber et al., 2021) has other benefits such as improved playability, increased player motivation, and increased engagement.

However, the use of DGDB is not without its drawbacks. One potential problem is that the game may become too easy or too difficult, causing players to lose interest (Vicencio, 2016). In addition, implementing DGDB is challenging for game designers and requires a careful balance between game mechanics and algorithms. According to Sepulveda, Besoain, & Barriga (2019) lack of development experience can make it more difficult to select and correctly apply algorithms, leading to poor implementation, which can lead to conflict in the game. There is also a risk that because DGDB is a mandatory procedure for players, DGDB may be perceived as unfair or too aggressive, thus degrading the player's gaming experience (Cherukuri & Glavin, 2022). As Vang (2022) suggests, if the DGDB implementation is too strong, its aim is to win rather than to provide a challenge, it may discourage less skilled players from continuing to play the game.

2.1.2 Usability and Engagement
Olsen et al. (2011) argued that GUX is an important consideration in modern video game development. A critical aspect of GUX is usability, which refers to the probability or time occupancy expectation that the system will function properly at a given time of examination. Many studies have focused on usability in game design, Capece et al. (2020) developed a 3D puzzle game that attempts to keep the information contained in the game in the player’s mind through the feelings experienced during gameplay, and they designed a controlled experiment to evaluate the impact, user experience, usability, and effectiveness of the tool. Another critical aspect of GUX is engagement, which refers to the degree to which players are motivated to continue playing the game. Research has shown that engagement is positively correlated with player enjoyment and is a critical factor in determining whether players will continue playing the game (Zou et al., 2021; Nacke et al., 2010).

As player game data and analysis become more accurate and clearer, game developers can target their games to meet players’ current gaming needs and preferences. In addition, good GUX design not only helps developers create engaging and immersive games, but also makes game design richer and more complete (Ike et al., 2021).

2.1.3 Flow
According to Csikszentmihalyi (2000) flow is a psychological concept that describes an optimal experiential state in which a person is fully immersed in an activity, achieving a perfect balance between challenge and skill. Hamari et al. (2016) used a similar description of the flow, emphasizing the importance of balancing the challenge with the skills to achieve it. Perttula et al., (2017) suggested that in terms of game user experience design, flow has become
increasingly important as game designers strive to create engaging game experiences that keep players coming back for more.

Several studies have examined the relationship between in-game challenge and the expertise of flow. The first study proposed that players move through "flow channels" when they are out of a state of boredom or frustration (see Figure 1). A study by Hendricks, Bellamy-Wood, and McKay et al. (2018) proposed that users are most engaged when there is a balance between difficulty and skill, leading to a state of "flow." In another study of first-person shooters, Nacke and Lindley (2010) found that players who experienced "flow" had higher challenge ratings than those who did not. Similarly, in a study of mobile puzzle games, Nacke and Lindley (2008) found that players who experienced "flow" had higher skill ratings than those who did not. These findings suggest that carefully balancing challenge and skill in games is a key factor in creating a smooth experience.

![Figure 1](image.png)

**Figure 1**  Flow channel concept proposed by Csikszentmihalyi (2000)

According to Andersson and Strömsholm (2018) immersion is considered a key part of designing creative and innovative user experiences in the digital gaming industry. Oliveira and Tavares (2018) argued that immersion is an important aspect of the game user experience. Cheng, She, and Annetta (2015) found that immersion had a positive impact on learning outcomes, especially when players' game performance was high.

Nacke and Lindley (2008) suggests that one could see immersion as a precondition for flow, as immersion involves a loss of a sense of context, whereas flow describes a level of full engagement. Hamari (2016) investigated the impact of flow (materialized as higher challenge and skill), engagement, and immersion on learning in a game-based learning environment. The data were collected through a survey of two learning games. The results show that both game challenge and game skill positively affect engagement and immersion in the game.
2.1.4 Eureka effect (a-ha moment)

According to Sprugnoli et al. (2017) the Eureka Effect (also known as the a-ha moment) is defined as an enlightening experience that describes the process of insight that culminates in an "unpredictable moment of extraordinary thinking." Originating from Archimedes' famous exclamation during his bath-time revelation in ancient Greece, this term has come to symbolize that exhilarating moment when a solution suddenly materializes seemingly out of nowhere (Verma, 2015).

The Eureka effect has also been used in game studies, for example McKinney et al. (2013) used the Nim game to investigate the Eureka effect. The results indicated that the subjects in their experiment showed Eureka learning abilities in the complex game of Nim, which could be solved using heuristics. According to Loesche, Goslin, & Bugmann (2018), the "Dira" task served as an experimental platform to record behavior at the onset of the Eureka effect. They estimated the moment of solution based on participants' behavior and self-reports, without relying on additional indicators. Their results suggest that the Eureka effect is not limited to the presence or absence of insight, however confidence, perceived task difficulty, and well-being are correlated with the strength of the reported eureka experience. Magana et al. (2022) examined the affective and cognitive effects of learning through computer simulations and computer video games. The results of the study indicated that students in the game-based learning condition were significantly more engaged, perceived more a-ha moment, and experienced more frustration; perceiving more engagement resulted in higher a-ha moment.

2.2 Puzzle games

According to Linehan et al. (2014) puzzle games can be defined as games that require problem-solving skills to complete. The earliest known puzzle game is the Chinese tangram, which dates back to the Song Dynasty (960-1279) (Nowlan & Nowlan, 2017). In the 18th and 19th centuries, jigsaw puzzles became popular, and in the 20th century, crossword puzzles and Sudoku gained widespread popularity (Connor, 2014). Chi, Agama & Prodanoff (2017) argue that puzzle games have gained a large following in recent years due to their popularity in mobile gaming and their ability to improve cognitive skills.

Researchers have examined the design principles behind successful puzzle games. Linehan et al. (2014) identified several key design principles, including the use of clear goals, feedback, and progressively increasing difficulty. Chi, Agama and Prodanoff (2017) identified the importance of incorporating an element of surprise into puzzle games and the need for players to feel in control of the game.

In the past decade, puzzle games have become an important area of research in the fields of game design and cognitive psychology. Researchers have studied the effects of puzzle games on cognitive functioning and the use of puzzle games in educational settings (Linehan et al., 2014; Chi, Agama & Prodanoff, 2017). Puzzle games have been used for educational purposes, such as improving cognitive skills, problem-solving skills, and decision-making processes (Reynaldo et al., 2021). Puzzle games are capable of improving cognitive skills such as problem-solving, memory, and spatial reasoning (Chein & Morrison, 2017; Linehan et al., 2014). These games require players to think critically and strategically to solve puzzles, and this mental exercise can lead to improvements in cognitive functioning (Chi, Agama & Prodanoff, 2017). The accessibility of puzzle games also contributes to their popularity. Puzzle
games are released on a variety of platforms, from mobile devices and consoles to desktop computers (Franco & DeLuca, 2019).

2.3 Puzzle games & DGDB

Some researchers have made attempts to study the effects of DGDB in puzzle games. According to Drachen et al. (2012) DGDB can adjust the difficulty of the game according to the player skill, thus increasing the game difficulty of the puzzle game. Juul & Keldorff (2010) developed a DGDB algorithm for a popular puzzle game called Bejeweled Blitz. The algorithm adjusts the difficulty of the game depending on the player’s skill and game progress. The results indicate that the DGDB algorithm increased player engagement and satisfaction compared to static difficulty settings. However, this study only focused on one puzzle game, and it is unclear whether the findings can be generalized to other puzzle games. Hendrix et al. (2018) did this by applying the DGDB system to a mobile game with puzzle-solving mechanics as well as a classic platformer. Small-scale user evaluations were conducted on both games, comparing versions with the DGDB system with versions that did not show that they worked as intended. It remains important to manually determine the optimal balance for the target audience, as this can heavily influence the experience when playing the game for the first time. Gonzalez et al. (2021) proposed a new approach called Fast Bayesian Content Adaptation, focusing on the use of DGDB in games. By modifying the optimization of the acquisition function, they are able to reliably present content with customized difficulty levels for players of different skill levels, with less than five iterations of Sudoku. Experiments show that this approach is able to quickly find levels with the target difficulty and a obviously shorter distance to the target.
3 Problem

Puzzle games have been a popular topic of research over the years, and researchers have investigated various aspects of these games. Despite the potential benefits of DGDB, its impact in puzzle games needs more exploration and research.

This thesis explores the intersection of DGDB, GUX, and puzzle games. DGDB system, which dynamically adjusts game parameters based on player performance (Andrade et al., 2006; Zohaib, 2018), has exhibited the potential to enhance player satisfaction and engagement across various gaming genres.

In contemporary game development, GUX holds paramount importance, emphasizing usability and engagement (Olsen et al., 2011; Capece et al., 2020). When applied to puzzle games, GUX encapsulates the creation of a seamless and enjoyable gaming experience that fully immerses players in the intricacies of gameplay (Nacke et al., 2009; Chi, Agama & Prodanoff, 2017).

However, the successful implementation of DGDB in puzzle games faces unique challenges. As noted by Andrade et al. (2006), it must meet three key criteria: identifying players' individual skill levels, meticulously tracking player behavior, and maintaining a believable game progression to avoid player coercion. While DGDB has potential benefits, such as increased playability, motivation, and engagement (Huber et al., 2021), it also presents potential drawbacks, including the risk of making games too easy or difficult (Vicencio, 2016) and the complexity of algorithmic choices (Sepulveda, Besoain, & Barriga, 2019).

While the DGDB system has been studied in a variety of game environments, there is still a need to investigate how DGDB implementations specifically affect engagement, immersion and a-aha moment in puzzle games. This study's central research problem, therefore, can be defined as follows:

"How does the integration of a DGDB system in a puzzle game affect the game user experience by analyzing the player's engagement, immersion and a-aha moment in the game?"

To address this inquiry, a puzzle game was developed and a small pilot test was conducted. At the end of the pilot test, the DGDB system was added to the game, resulting in two different versions of the game prototype. Two groups of participants were participated in these two versions of the game, each trying to complete as many levels as possible. Their gameplay data was be carefully recorded, in which the flow channel (Csikszentmihalyi, 2000) constituted by player expertise as well as game challenge serves as an important measure of player experience. In addition, participants were asked to fill out a structured questionnaire after completing the game session, with a-aha moment and some subjective questions serving as important benchmarks for analyzing player engagement. After these collected data sets are analyzed one by one, we can answer the core research question of the thesis.
4 Method

4.1.1 Procedure
To examine the impact of incorporating the DGDB system into a puzzle game on participants' gaming experiences, the researchers devised a comprehensive three-stage experiment. Initially, we conceived and crafted a puzzle game prototype. In the subsequent phase, pilot participants were enlisted to engage with the game, and we captured some real-time gameplay data from their playtest session. In the final segment, we seamlessly integrated the DGDB system into the game with the data we gathered from the pilot test. And formal participants were invited to play the game and complete a questionnaire comprising both structured and open-ended inquiries, aimed at assessing their interaction with the game.

Since it is not possible for researchers to add the DGDB system by modifying an existing puzzle game program, the researchers had to decide to use their own developed puzzle game as the core game for this experiment.

The researchers developed a prototype puzzle game called "Ice Sokoban" (Wu, Lin & Wang, 2022), which contains 17 different levels, offering participants a time-unrestricted gameplay experience. Players had the freedom to advance to the next level at their discretion and could opt to conclude the game at any juncture. Two versions of the game were tested: one without any hints and the other equipped with the DGDB system. This study references Juul & Keldorff’s (2010) research on the DGDB system in Bejeweled Blitz. Based on the original Bejeweled Blitz game, we referenced one-button elimination of specific color squares as a way to help the player and combined it with Ice Sokoban’s game mechanics to create a new DGDB system. The system was designed based on the average playing time of each player in the experimental group in each level and the player’s game performance in order to minimize disruption to players from interfering cubes (See Figures 2-5), a detailed explanation of the use of the DGDB system in this game is given later in 4.1.6 Pilot Test. Apart from the presence of the hint system, the content of both versions of the game was identical, with the only difference being the game cover, which was used to clearly differentiate between the versions used.
**Figure 2**  Interfering cubes in Level 16

**Figure 3**  The first time interfering cubes disappears in Level 16
In total, 34 participants took part in this experiment. They were randomly divided into two groups: each group was asked to play one version of the game and attempt to complete all levels, and there was no time limit, as the player could terminate at any time during the game. 24 participants shared the screen and played online during the game, while 10 participants...
played the game in the field, where their gameplay data was recorded in real time. Group A was assigned to the experimental group and played the version of Ice Sokoban equipped with the DGDB system, which adjusts the difficulty of the game in an intermittent manner according to the player's time spent in each level. (See figure 6)

![Figure 6](image.jpg)

**Figure 6** The experiment procedure

Group B played the standard version without the DGDB system as a control group. Both groups of participants recorded game data during the game, including levels completed, time taken for each level, total game time, including the time used before the player gives up and number of restarts for each level. At the end of the game, all participants were asked to fill out a questionnaire that included some structured questions and some open-ended questions. In addition, 10 participants were involved in the field in order to observe and feel the participants' emotions and facial expression changes in real time.

The cornerstone of the experiment was the questionnaire, which was bifurcated into two segments. The first segment delved into players' fundamental profiles, personal competencies, and their subjective impressions of the game. The second segment featured a series of open-ended queries, soliciting participants' perspectives on the DGDB system and their overall gaming experiences. This approach facilitated the unencumbered expression of participants' experiences, thoughts, and suggestions. Comprehensive details of the questionnaire can be perused in Appendices A & B.

Following the completion of the questionnaire and the aforementioned three phases, the researchers randomly selected participants for in-depth interviews. All participants were friends invited by the researchers. The interview questions were aligned with those in the questionnaire, designed to evaluate participants' gaming encounters. Prior to commencing the experiment, participants were informed whether the version they were engaging with featured the DGDB system. However, they were not provided with an intricate elucidation of its mechanics or presentation within the game.

### 4.1.2 Material

A prototype puzzle game called "Ice Sokoban" was used for this experiment. The game mechanic of this game is based on the design of the Sokoban, the player needs to push the ice cubes to target places. The ice cubes in the game have some physical properties of ice, such as
the ice cubes will slide on the ice, and the ice cubes will melt when they touch fire, etc. Each level of Ice Sokoban has the same level objectives: the player must push the corresponding number of ice cubes to the designated target point in order to pass the level. The character model pushes the ice cubes on the grass, and the ice cubes will stop at the next plot due to the friction between the ice cubes and the grass. The character model pushes the ice cube on the ice surface. Since there is no friction between the ice cube and the ice surface before, the ice cube will slide on the ice surface, but if the ice cube meets the grass during the sliding process, the ice cube will stop on the grass. The fires and wood piles in the game are obstacles, and the character models cannot pass them. The ice cube will stop if it meets the wood pile, and if the ice cube meets the fire, the ice cube will be melted and the fire will be extinguished while turning the wood pile into an obstacle. There is a sticky effect between the ice cubes and the ice cubes. When the ice cubes are stuck together, they will not slide, but when they are pushed to stick together, the ice cubes will slide together. Players need to try and observe in the level to discover these rules and plan the route, so as to complete the goal.

4.1.3 Instrument
Within the first and second segments of the questionnaire, it was essential to establish a framework that would enable researchers to gauge participants’ gaming experiences more precisely. A selection of 17 to 18 questions within the questionnaire served to understand the participants’ gaming experience (please refer to Appendices A & B). This survey instrument was rooted in the Game User Experience Satisfaction Scale (GUESS), initially formulated by researcher Phan et al. (2016). However, it underwent scrupulous adaptation and customization to align with the specific objectives of this research endeavor seamlessly.

In this context, the multiple-choice questions featured in the first part of the questionnaire were designed utilizing a 5-point Likert scale, ensuring a comprehensive assessment of participants’ experiences.

4.1.4 Questionnaire
In order to meet the current urgent research deadlines and to ensure efficient sampling, all participants have been carefully selected from within our friends. They were instructed by the researcher to complete the questionnaire to ensure that the responses matched the actual situation. The post-game questionnaires (Appendix A & Appendix B) are divided into two groups A&B and subdivided into sections. The questionnaire begins with questions that collect some basic information about the players, such as their age and gender, and their relationship with video games and puzzle games, such as how much time they spend playing each week and how often they play puzzle games. These questions were collected to provide some basic understanding of the participants and could be useful in terms of demographic significance.

The second section is the core part of the questionnaire, which is about the core experience of the game. This section, except for the last open-ended question that asks players to choose between strongly disagree, disagree, neither agree nor disagree, agree, and strongly agree, with the game experience aspect requiring a choice between one and seven to quantify players' perceptions and their experience of the game. Refer to Zou et al. (2021) argued that engagement is positively correlated with player enjoyment and is a critical factor in determining whether players will continue playing the game. So, participants were asked to answer questions, "I felt I want to continue to the next level. This question was used to understand the participants’ immersion in the game. And “I found Ice Sokoban fun to play." It was to study the level of engagement of the participants. According to Csikszentmihalyi
(2000), he used challenge and expertise to determine flow channel, and this study will determine participants' flow channels by how often they play puzzle games and how difficult they feel the game is to play.

The final part of the questionnaire consisted of open-ended questions to gather feedback from participants on topics such as the DGDB system, the relationship between the DGDB system and the puzzle game, and the game experience. For example, "Do you think it's necessary for puzzle games to have a DGDB system that helps players complete the game? Please explain it." According to Loesche, Goslin, and Bugmann (2018), they estimated the moment of resolution based on participants' behavior and self-reports, without relying on other indicators. So, participants were asked to answer the question, "If you encounter any a-ha moments while playing Ice Sokoban, please write them here." This question was asked to investigate whether participants had a-ha moments in the game. The answers to these questions will later be evaluated and analysed in a qualitative way as a whole.

4.1.5 Ethical consideration
This study is fully compliant with Swedish laws and social ethics regarding science and technology. Participants will not experience any physical or mental harm during the study, and the results will be used solely for the purposes of this report. Before the participants play the game Ice Sokoban, they will receive a comprehensive explanation of the study’s intent and purpose, as well as how the resulting data will be used. Participation in the experiment is voluntary, and participants may terminate their involvement at any time if they feel uncomfortable or wish to withdraw, without providing a reason.

All data collected during the experiment will be used only for analysis and report preparation and will be deleted immediately upon the report’s completion. The report will be written in a manner that ensures the anonymity of participants, preventing any negative impact on their lives, and protecting their identity from being traced from the data. Participants have been informed that the results of their experiment will be used solely for the purpose of writing this thesis, and may also be published in the Diva database. Participants may be contacted to obtain the results of the experiment.

4.1.6 Pilot Test
Prior to the start of the formal experiment, the research team conducted a pilot test aimed at ensuring the validity of the experimental design and reducing the likelihood of subsequent errors in the formal experiment. In this pilot test, the researchers recruited five participants and improved the questionnaire based on the suggestions and answers they provided (no modifications to the questionnaire framework or process were involved). During the experiment, the researchers recorded all the experimental data in detail, which will become an important reference basis for the design of the DGDB system. For example, during the game, the researchers recorded the moments when the participants showed anxiety or frustration, and when their facial expressions showed situations such as melancholy or distress. In addition, participants were asked to complete questionnaires so that the researchers could understand why they chose certain answers and compare those answers to the expected results. Regardless of whether the results were positive or negative, participants were asked about their reasons for choosing certain answers and comparing those answers to the expected results.
Over the course of the pilot test, the researchers calculated the average time point at which each player experienced anxiety in each level, based on the time spent recording when participants experienced frustration and stuck behavior. They then used these averages to determine the time points at which cues appeared, and set the appropriate number of cues and divided the time points according to the level's difficulty level. The researchers found that the five participants showed varying degrees of anxiety, such as sighing, anger, and facial grimacing, five minutes into each level. As Levels 1-7 were guided levels with relatively low difficulty, no hints were set. Levels 8-14 were of moderate difficulty with two hinting points. Levels 15-17, on the other hand, were the levels that participants spent the most time on and were also of high difficulty, so three cue points were set. Based on the above, the researchers decided to set the time for the first cue point at 300 seconds. The time for the third cue point was then based on the average time for each level for the five players. The time for the second cue point was then taken as the average of the first and third cue point times.

After the pilot test, the researchers also found some questions that confused the participants. They felt that there were several questions that dealt with similar aspects that led to confusion in the answers, thus affecting the researchers' understanding of the participants. Therefore, the researchers made moderate changes to these questions to improve the clarity and comprehensibility of the questionnaire.

The participants also provided some unique insights. For example, in the first section of the questionnaire, the option on the level of fun of the game left the player with the task of having to make an exact choice between five levels. As a result, the researchers decided to add two additional options to the Likert 5-level scale in a subsequent formal experiment to capture participant ratings at a finer level.
5 Results

5.1 Background data

Two different questionnaires were used to collect data for this experiment, each questionnaire corresponding to a group of participants. A total of 34 people participated in the experiment. Of the 17 participants in Group A, the age range ranged from 20 to 33 years old, with an average age of 24 years old. In contrast, the participants in Group B ranged in age from 22 to 35 years old, with an average age of 25. The overall age of the participants in both groups was similar.

In Group A, 70% of the total number of participants were male and 30% were female. In Group B, 77% of the total number of male participants and 23% of the total number of female participants were male. It can be seen that the majority of the participants in this experiment were male.

Regarding the participants' gaming habits, in Group A, 12 participants played video games more than 20 hours per week, while in Group B, 8 participants played video games more than 20 hours per week. It can be seen that the frequency of gaming among the participants in Group A was obviously higher than that in Group B (See Figure 7).

How long do you usually play video games each week?

![Bar chart showing gaming habits](image)

**Figure 7** Group A & B answered the question "How long do you usually play video games each week?"

As can be seen (See Figure 8) from the participants' relationship with puzzle games, it is clear from the data that neither group of participants played puzzle games on a regular basis, and there were almost no hardcore players of puzzle games.
Figure 8  Group A & B answered the question "How frequently do you play puzzle games (puzzle video games) in all video games?"

5.2 Participant performance

In the Group A, all players passed all levels except one participant. In the experiment of group B, only 59% of the participants completed all the levels. In Group A, which has the DGDB system, the rate of participants passing the levels is much higher than that of Group B participants.

In both groups, all participants successfully passed from level 1 to level 11. However, it is worth noting that all participants in Group A successfully passed levels 1 through 12 in the test. In the Group A test, only 1 participant chose to abandon the game when challenging level 13, while all other participants successfully completed all levels. In Group B, 1 player gave up the game in the middle of the test, and 6 other players failed to solve all the puzzles, for a total of 7 participants who failed to complete the game.

The graphs (See Figure 9) show the average time (in seconds) that the two groups of participants spent in each level to pass the levels. Both groups of participants took similar amounts of time to pass the levels.
Figure 9  Average level completion time for participants in both groups

5.3 Participant perceptions

In this test, players were not given any instructions on the rules, players learnt all the game mechanics through the game, and the developers hoped that players could break through the confusion to find the answers. As can be seen from the graph (See Figure 10), most players were able to understand the rules and mechanics of the game, half of the participants were not confused during the game, a third of the participants tended to be neutral, and only a very small percentage of the participants were confused all the time. The figures are almost the same for both groups of participants.
Figure 10  All participants answered the question “I felt confused in each level.”

In terms of gameplay considerations, all but one of the participants in Group A said they would like to continue playing the next level, and 14 participants in Group B said they would like to continue playing the next level (See Figure 11).

Figure 11  All participants answered the question “I felt I want to continue to next level.”

The question on whether Ice Sokoban was easy to play was designed to get a sense of the participants' judgement of the game's difficulty. 1 indicates easy and 7 indicates difficult. None
of the two groups of participants chose 1 and 2, indicating that no one thought the game was easy, and the number of people who chose 3 and 4 was also very small. Most of the participants thought the game was between 5 and 7 in terms of difficulty. However, when comparing the two groups, the number of people who found the game difficult in Group B was twice as many as in Group A. (See Figure 12).

Figure 12 All participants answered the question “I found Ice Sokoban easy to play.”

To find out how much fun Ice Sokoban is, the researchers divided the degree of fun from 1-7, with 1 being fun and 7 being boring. the vast majority of players in both groups of participants chose 1-3, which they thought was fun, and a very small number of players chose 4-6, which they thought was average fun, but none of the participants thought the game was boring (See Figure 13).
All participants answered the question “I found Ice Sokoban fun to play.”

In order to investigate the effect of the DGDB system on flow channels, the researchers used participants’ frequency of play in a puzzle game as a metric of player experience, as well as the players' self-perceived level of difficulty to assess the game challenges. This study draws on Csikszentmihalyi’s (2000) theory of flow channels, with targeted modifications to adapt it to the current experiment. In the absence of a device to monitor each player's state in real time, the researchers ended up using an exponential function to segment the flow channel and inferred each participant's state of heart flow by analyzing their coordinate points. The level of challenge of the game was categorized into seven different levels, while the player expertise was categorized into five different levels, which matched the data provided by the participants. The researchers then used the exponential function’s model of the cardiac flow channel to match the participants' two sets of data one by one, ultimately resulting in the coordinate points of each participant’s cardiac flow channel state (See Figure 14 and Figure 15).

In Group A, 3 participants were in the flow channel, 7 participants were close to the flow channel, 7 participants were away from the flow channel, and 1 was frustrated. In Group B, 11 participants were close to the flow channel, 2 participants were away from the flow channel, and 4 were frustrated. However, none of the participants were able to access the flow channel. Ultimately, the researchers compared the data from Group A and Group B. The results of the study showed that in Group A, the participants were not able to enter the flow channel. The results showed that in Group A, 3 participants managed to enter the flow channel, while no one in Group B was able to achieve this status (See Figure 16 and Figure 17).

However, the actual feelings of the players must be evaluated by the participants through the subsequent open-ended questions.
Figure 14  Segmentation of flow channel using exponential function

Figure 15  Player expertise and Game challenge statistics for all participants
In Group B, most of the participants felt that they were able to complete the game without help. However, in the experimental group of group A with the DGDB system, most of the participants felt that the DGDB system helped them to complete the game.

During the test, as the participants remained engaged in the game, researchers were able to use restart count as a determining factor to identify instances where players were stuck. The restart count is an indication of the participants' ongoing thinking, and there is no apparent difference between the restart counts of Group A and Group B (See Figure 18). The data is recorded here for future work as well.
**Figure 18** All participants restart count

Please see below Appendix A and Appendix B for the full text of the questionnaire.
6 Analysis

Demographically, the two groups of subjects in this experiment were similar in terms of age, gender, and how often the subjects played puzzle games. However, Group A played video games for a longer period of time per week than Group B did. The level design and number of levels used in the two experimental groups were identical. Therefore, the data obtained in the experiment have some reference and comparison value.

From the data recorded by the 34 participants during the game, Group A had a clearly higher-level completion rate than Group B. The level completion rate of Group A was higher than that of Group B. In both groups, the participants encountered difficulties on levels 13 to 17, resulting in failure to complete the game. In Group A with the DGDB system, which was the experimental group, all 17 participants completed all levels except one participant who did not pass all levels. However, in Group B without the DGDB system, for the 17 levels, seven participants failed to complete the level, and one player even gave up playing the game directly from level 12 onwards. It can be seen here that the DGDB system largely determines the players' clearance rate.

When both groups of participants answered the question "I am confused about each level", their responses were almost identical. This suggests that all participants had similar levels of game comprehension, and that both groups were in a similar state during the game.

The responses to the questions "I found Ice Sokoban fun to play." and "I felt I want to continue to the next level." were positive. The feedback from both groups was positive. There were no apparent differences in the responses to these two questions, which means that both groups of players showed a high level of engagement and motivation.

The core of the questionnaire was to understand the impact of the DGDB system on the user experience of puzzle game players. The Flow channel was derived from the game’s game challenge and player expertise. Using the data, we find that DGDB does improve player engagement to some extent, although this effect is not very obvious due to the relatively small number of participants. However, it is important to note that the "flow channel" can only provide an approximate range of results, and it is not possible to determine a one-to-one correspondence between a specific value and an effect, which is a difficult part of the overall experimental data analysis.

In the last multiple-choice question, the questions were slightly different between Group A and Group B. Group A's question was "I found that DGDB helped me to finish the game", while Group B's question was "I found that DGDB did not help me to finish the game". The majority of participants answered positively. This suggests that the inclusion of the DGDB system does help players to complete the game, even though it is not required for puzzle solving.

However, analyzing the data from the two groups of participants with and without the DGDB system only, it appears that the rate of passing the game is affected, but other aspects of the game are not apparently different. Therefore, in order to gain a more intuitive understanding of the true feelings and perceptions of the players, we still need to rely on the responses to the open-ended questions. Further analysis needs to take into account the feedback from the open-ended questions later in the questionnaire.
Regarding the first open-ended question, i.e., players' general views on DGDB systems in video games, the application of DGDB systems is different for each game genre, and naturally each participant was exposed to a different one, so the answers received were not uniform. Some of the participants felt that the DGDB system is very necessary, which can reduce players' frustration in the game, and players can adapt to the pace of the game, which can help players complete the game more easily. However, for hardcore players, the addition of the DGDB system will obviously reduce their gaming experience, which is likely to lose some players. Some participants feel that it depends on how the DGDB system is designed, and if it can control the balance of the game well, then it is a great design. A small percentage of players feel that such a system is undesirable and will take away from the fun of the game, leading to no experience at all.

For the second question, the researchers asked both groups of participants the same question: "Do you think it's necessary for puzzle games to have a DGDB system to help players complete the game? Please explain." The two groups of participants disagreed on this question, with most of the participants in Group A saying that a DGDB system is very necessary for puzzle games, and that players who get stuck in the wrong mindset for a long time will not be able to complete the levels and will eventually give up on the game. If there is such a system in a puzzle game, it can give players the motivation to keep playing, and the indirect hints will not undermine players' self-confidence, and at the same time it can also inspire players to complete the game on their own, so that they can feel a sense of satisfaction. Most of the participants (Includes all participants who have not completed all levels) in Group B think that the use of the DGDB system in puzzle games is very unnecessary, and that the core of a puzzle game is that it has an inherent difficulty system, and once this is broken, it will be difficult to complete the game. Once that is broken, the game is unbalanced. Some of the participants also felt that there could be a few hints that would make the player feel more engaged and the gameplay smoother. Of course, the answers to this question will vary depending on each participant's understanding of how the DGDB system is used in puzzle games, and more precise and intuitive answers can be found in the next two questions.

The third question in Group B was more specific than any of the questions between, "What are your thoughts about reducing Interference terms as hints to the player?" (In Ice Sokoban, what was the participant’s opinion if this way of reducing the number of squares interfering with the player’s puzzle solving was used as a hint?), the game’s DGDB system in this experiment used of reducing interference cubes. Most of the participants answered positively to this question, thinking that this is a reasonable approach that will not break the gameplay or reduce the fun of the game, and that it will be a good attempt. The third and fourth questions in Group A were about the use of the DGDB system in Ice Sokoban, and the answers were surprisingly consistent, with almost all participants giving positive answers. gave positive answers that the design was fantastic and useful. In the later levels, players felt relieved when they suddenly find the existence of such hints, and the system will secretly help players to eliminate some interference items, and finally find the correct path by themselves. One player even commented that "For this game, that choice is a near-perfect way to hint."

The last two questions were the same for both groups, and the answers to the questions about whether the players experienced any confusion during the game and whether there were any moments of enlightenment were more or less the same for both groups. Where the vast majority of participants felt there was no confusion, and where a small number of participants were confused, was in the sliding mechanism of the ice cubes on the different surfaces. When
participants were asked where they might have had an a-ah moment, they said they were amazed to varying degrees when they learned that fires could be extinguished by ice cubes, that ice cubes would stop when they hit grass, that ice cubes could be connected, and that changing the order of operations would allow them to pass the level. Overall, there were no apparent differences between the responses of the two groups.

Therefore, the preliminary analysis of the performance of the two groups of participants in terms of objective data and answers to open-ended questions shows that almost all participants in Group A completed all levels with the help of the DGDB system and expressed a positive evaluation of the DGDB system, they felt that the DGDB could help them complete the game better and that the format would not undermine their confidence, and that giving hints to players indirectly was a clever approach that not only did not undermine the balance of the puzzle game, but also did not detract from the fun of the puzzle game and was a new experience. Giving hints to the player indirectly is a clever approach that not only does not upset the balance of the puzzle game, but also does not detract from the fun of the puzzle game, which is a completely new experience. However, in Group B, which does not have the DGDB system, the participants were still able to complete the game normally, but the completion rate was not high, and some participants even gave up at the beginning of level 12, and most of the participants said that the fun of a puzzle game is solving puzzles, and that they really want to give up if they get stuck. However, it is acceptable to give hints indirectly without upsetting the balance of the game. Overall, both groups of participants agreed that the DGDB system with indirect hints can have a positive effect on puzzle games.

Please see Appendix C for the answers collected to the open questions.
7 Conclusions

7.1 Summary

The DGDB system is widely used in other game categories. However, the core of puzzle games is to solve puzzles, the reason why few puzzle games use the DGDB system, developers will worry about whether this will break the balance of the game, in this experiment the researchers made a bold attempt to try to add the DGDB system in the puzzle game is also to verify that how does the integration of a DGDB system in a puzzle game affect the game user experience by analyzing the player's engagement, immersion and a-ha moment in the game?

Some preliminary conclusions can be drawn from the experimental data and analyses: almost all of the participants in Group A completed all the levels, with a completion rate as high as 98%, while the completion rate of Group B was only 59%. This also shows that DGDB can improve players' completion rates to some extent.

From the analysis of the flow channel, In Group A, 3 participants managed to enter the flow channel, while no one in Group B was able to achieve this status. According to Hendricks, Bellamy-Wood, and McKay (2018), user engagement is highest when there is a balance between difficulty and skill, which leads to a state of "flow." These data clearly show that the DGDB system is able to increase player engagement to some extent.

According to Zou et al. (2021), there is a positive correlation between engagement and player enjoyment, however, the current data shows that the presence of the DGDB system has little impact on player engagement and immersion.

In addition, when Group B participants were asked whether DGDB was necessary in puzzle games, most of them thought that it was not necessary. This is also due to the fact that the DGDB system is not well known in puzzle games, and players would think that puzzle games usually don't need the support of DGDB, which is also people's unconscious understanding of puzzle games. But when Group A participants played Ice Sokoban with the DGDB system, almost all of them thought it was a good idea. After all, puzzle games are not only about thinking, but also about the satisfaction that comes from solving puzzles. If players are overwhelmed by difficult levels in a puzzle game, many of them will choose to use cheats, and some of them will even give up the game, which will lose the meaning of the puzzle game.

However, the participants also said that they could not accept direct or obvious clues as a method of DGDB, which would result in a big blow to the players' confidence and eventually lose them. Some other people in both groups of participants thought that puzzle games are for different audiences of players, for casual players the inclusion of the DGDB system will make them feel relaxed and confident, but for hardcore players it is a mental torture, they are keen to find answers from difficult propositions, and the inclusion of the DGDB system will to some extent destroy their thinking process. To obtain clearer reference comparisons, the DGDB system in this instance is set to be mandatory, with prompts appearing intermittently when specific times are reached. This intermittent approach makes it difficult for participants to perceive the presence of the prompts, thereby preventing any clear visual disruption or negative feelings for the players. This corroborates Cherukuri & Glavin's (2022) view that the DGDB is a mandatory procedure for players, DGDB may be perceived as unfair or too aggressive, thus degrading the player's gaming experience.
Based on the current questionnaire results, it appears that the inclusion of the DGDB system is not directly associated with the occurrence of a-ha moments for the participants. Responses from both test groups predominantly revolved around their experiences with game mechanics and puzzle solving when describing their a-ha moments, with only a very small number of participants providing feedback on the insights gained from the DGDB system.

To summarize, the DGDB system has some utility in puzzle games, but it is not essential. Its applicability depends on the difficulty and mechanics of different puzzle games, so not every game is suitable for introducing the system. In addition, providing the player with hints that do not obviously affect the gameplay process while keeping the gameplay experience uninterrupted is a challenging task.

However, in the specific game of Ice Sokoban, the introduction of the DGDB system was able to improve the player experience. By providing indirect hints, the system was able to assist the player in solving the puzzles and successfully completing the game, thereby gaining the satisfaction of solving the puzzles. Based on the participants' flow states, the DGDB system was able to improve player engagement to some extent. However, there was no apparent difference in the responses of the two groups of participants regarding immersion and "ah-ha" moments. Therefore, based on the results of the current experiment, the effect of the DGDB system on players' gaming experience in puzzle games is not obvious. Further research and discussion are needed to determine its actual effect.

7.2 Discussion

All of the participants in this experiment were friends of the researchers, a choice that brought with it a number of distinct advantages. First, recruiting friends as participants greatly saved the time and effort required for recruitment. Working with friends is usually more efficient and rapid, as they are often more willing to actively assist. In addition, conducting an experiment with a friend is easier to schedule and locate, which helps to ensure that the experiment runs smoothly. Compared to working with strangers, collaborations between friends are easier to organize and manage because communication with each other is more fluid. It is also worth noting that the researchers' friends were all interested in games, which helped to ensure that they were able to be more attentive during the experiment. However, conducting experiments with friends also comes with some potential disadvantages. Firstly, there may be an interpersonal element between friends, which may lead them to provide results that favor the researcher, thus producing inaccurate data as they may not be a true reflection of their thoughts or behaviors. Second, because friends may be familiar with the researcher's goals and expectations, they may be influenced by the researcher's expectations, which may affect the objectivity of the experimental results. Finally, friends are not necessarily representative of the wider population and therefore the results obtained from them may not generalize to the wider population, which can create some limitations.

The current results are partially consistent with the theoretical part of the field: the DGDB system in Ice Sokoban does not have obvious impact on the player's gaming experience. Typically, developers adjust the challenge of a game based on the player's individual skill level, but for puzzle games, focusing on this alone is not enough. In this experiment, the researchers adjusted the difficulty of the game based on the player's play time, ensuring that players stayed engaged without being overly challenged or losing interest due to lack of challenge. This
personalized approach encouraged players to gain a sense of personal accomplishment and motivation to keep improving (Ang and Mitchell, 2017). The importance of maintaining the delicate balance between maintaining the right level of challenge and avoiding being too easy and triggering prolonged boredom was re-emphasized by observing signs of fatigue encountered by participants in Group B, such as repeated failures or spending too much time on certain levels. In this case, providing indirect hints or temporarily simplifying the task could motivate Group A participants while they still managed to gain a sense of accomplishment, which is in line with Vicencio, Mandryk, and Gutwin's (2015) suggestion that a dynamic difficulty mechanism could alleviate the frustration often experienced by players who get stuck in challenging puzzles for long periods of time.

When gameplay becomes extremely difficult and beyond what the user can effectively handle, players may become irritated, triggering negative emotions such as anxiety, rather than experiencing pleasure or fulfilment. For example, one of the participants in group B appeared to have a major mood swing during the test because the difficulty of level 12 reached the limit of what he could accept, and eventually gave up to move on to the following levels. From this participant’s behavior, it can be concluded that the DGDB system is suitable for hardcore puzzle games, as it can keep the player more engaged and, to a certain extent, avoid some negative emotions.

In the current experiments, the researchers have defined the flow state somewhat narrowly. This is because the cardiac flow channel should be a curve, not just a coordinate point, and therefore the flow state we currently obtained is not accurate enough. Additionally, participants currently rated the challenge of the game based on the difficulty of the game as a whole, without evaluating the difficulty of each level individually. While it may be possible to obtain more accurate results if participants were asked to evaluate the difficulty of each level, this would also be more difficult because of the potential for subjective bias in participants’ evaluations without the aid of any instrumentation. Even if participants were asked during the post-competition visits, there is no guarantee that they would be able to accurately recall how they felt at the time. Therefore, we need to conduct more in-depth research and discussion in future studies to capture the flow state more accurately.

Discussion of a-ha moments was limited in the current questionnaire because the researcher’s survey was still in the preliminary research phase and time was limited, so only one question related to a-ha moments was included. This question was based on Loesche, Goslin, and Bugmann’s (2018) study that relied on participants’ behaviors and self-reports to estimate the moments in which they experienced a-ha moments during problem solving. While this approach is relatively intuitive, it has some limitations. The one-dimensionality of the question makes it difficult for researchers to obtain information about a-ha moments from multiple perspectives and dimensions. This is because a-ha moments typically include multiple aspects of thought, perception, and insight, and it is difficult to fully capture this phenomenon with only one question. Second, by relying only on self-reports and behavioral observations, this approach may not provide enough objective data to demonstrate the existence and impact of a-ha moments.

However, the challenge of implementing the DGDB system cannot be said to have been entirely successful, only that it has worked well in the current experiment. Game developers must strike a delicate balance between providing challenges that are neither too easy nor too
difficult. In addition, accurately collecting and analyzing player data can be resource-intensive, requiring powerful systems and algorithms.

Level design to some extent determines how the DGDB system is designed, and the level of difficulty of the levels directly affects the approach and operation of the DGDB; engaging and well-balanced levels promote cognitive development, problem-solving skills, and player immersion, thus increasing overall enjoyment. In addition, the DGDB system provides players with personalized challenges by adjusting complexity in real time according to individual skill levels. This feature ensures a satisfying experience while avoiding the frustration often associated with puzzles that are too difficult for individual skill levels. As puzzle games continue to appeal to audiences across platforms, understanding how level design and DGDB can positively contribute to their success will enable developers to create truly immersive experiences that cater to the preferences of different players. Of course, the question of the balance between level design and DGDB systems requires further investigation and research.

7.3 Future Work

At present, there are a number of shortcomings in this experiment. Firstly, the size of the experiment, with a total of 34 participants, is still not large enough to adequately show the differences in the data between the two groups. And the participants currently being recruited are all friends, which very likely makes the results of the experiment untrue. The differences in the experimental data are not obvious and the conclusions drawn still lack validity and verifiability. In addition, there was only one post-game questionnaire in this experiment, and the pre-game questionnaire was missing. This means that participants' answers to some questions in the questionnaire may have been influenced by the game process, which was not recorded. For example, in the open-ended question "Do you think it's necessary for puzzle games to have a DGDB system to help players complete the game? Please explain.", more participants in Group A thought it was necessary, but they completed the game with a DGDB system in place, and it is very likely that their initial viewpoint would have been different during the game. Therefore, it would have been more convincing if the answer to this question had also been recorded once before the player started the game, and the answers before and after compared.

Currently, we assess the player experience simply by asking questions, which is too one-dimensional an approach. Many of the reactions and feelings of the participants in a game often cannot be instantly recorded. In addition, relying solely on post-game interviews may miss a portion of the true player experience. In order to more comprehensively understand and record the player experience, future research should consider introducing some auxiliary means, such as facial expression capture and brainwaves, in order to more instantly access the participants' states and feelings. This will help provide insights into players' emotions and experiences in games, thus providing more comprehensive data to support the accuracy and depth of the study.

The flow channel applied in the experiment were not perfect, the center point was not in the flow channel and the positioning of the coordinates is also not accurate enough. The range of flow channel in the data analysis was vague and imprecise, and more determinants should be considered in the future, such as the player's puzzle-solving skills, players' time spent on playing puzzle games, and of course more dimensional considerations need to be explored.
Regarding the design of the DGDB system, the timing of the hints currently applies only to this experiment. However, when playing the game alone, players may engage in other activities simultaneously, making time an insufficient parameter to gauge if the player is stuck. To obtain a more accurate assessment, additional parameters such as number of failures, number of games, and time between each operation should be considered.
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Appendix A -

**Relationship between the players and puzzle games**

**How old are you?** *

*Your answer*

**What’s your gender?** *

- Male
- Female
- Prefer not to say

**How long do you usually play video games each week?** *

- ≤ 1 hour
- 1-2 hours
- 2-4 hours
- 4-7 hours
- 7-12 hours
- 12-20 hours
- ≥ 20 hours
How frequently do you play puzzle games (puzzle video games) in all video games?

- Very infrequently
- Somewhat infrequently
- Occasionally
- Somewhat frequently
- Very frequently

Game progress

Did you complete all the levels?

- Yes
- No
Game progress

Which levels of the game did you not complete? *

☐ level 1
☐ level 2
☐ level 3
☐ level 4
☐ level 5
☐ level 6
☐ level 7
☐ level 8
☐ level 9
☐ level 10
☐ level 11
☐ level 12
☐ level 13
☐ level 14
☐ level 15
☐ level 16
☐ level 17
I found Ice Sokoban easy to play

1 2 3 4 5 6 7
Easy

I found Ice Sokoban fun to play

1 2 3 4 5 6 7
Fun

I found that the DGDB help me complete the game

Strongly disagree
Disagree
Neither agree nor disagree
Agree
Strongly Agree
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are your thoughts on DGDB in video games in general?</td>
<td></td>
</tr>
<tr>
<td>Do you think it's necessary for puzzle games to have a DGDB system that helps players complete the game? Please explain it.</td>
<td></td>
</tr>
<tr>
<td>What do you think about the DGDB in Ice Sokoban?</td>
<td></td>
</tr>
<tr>
<td>What are your thoughts about reducing Interference terms as hints to the player?</td>
<td></td>
</tr>
<tr>
<td>If you encounter any confusion while playing Ice Sokoban, please write them here.</td>
<td></td>
</tr>
<tr>
<td>If you encounter any a-ha moments while playing Ice Sokoban, please write them here.</td>
<td></td>
</tr>
<tr>
<td>Do you have any more comments on Ice Sokoban?</td>
<td></td>
</tr>
</tbody>
</table>
Appendix B -

Relationship between the players and puzzle games

How old are you? *

Your answer

What's your gender? *

- Male
- Female
- Prefer not to say

How long do you usually play video games each week? *

- ≤ 1 hour
- 1-2 hours
- 2-4 hours
- 4-7 hours
- 7-12 hours
- 12-20 hours
- ≥ 20 hours
How frequently do you play puzzle games (puzzle video games) in all video games?

- Very infrequently
- Somewhat infrequently
- Occasionally
- Somewhat frequently
- Very frequently

Game progress

Did you complete all the levels *

- Yes
- No
Which levels of the game did you not complete? *

- level 1
- level 2
- level 3
- level 4
- level 5
- level 6
- level 7
- level 8
- level 9
- level 10
- level 11
- level 12
- level 13
- level 14
- level 15
- level 16
- level 17
Playing experience

I felt confused in each level

- Strongly disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly Agree

I felt I want to continue to next level

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
I found Ice Sokoban easy to play

1 2 3 4 5 6 7
Easy ○ ○ ○ ○ ○ ○ ○ Hard

I found Ice Sokoban fun to play

1 2 3 4 5 6 7
Fun ○ ○ ○ ○ ○ ○ ○ Boring

I found that I don't need DGDB help me complete the game

○ Strongly disagree
○ Disagree
○ Neither agree nor disagree
○ Agree
○ Strongly Agree
Some free text questions

What are your thoughts on DGDB in video games in general?

Your answer

Do you think it's necessary for puzzle games to have a DGDB system that helps players complete the game? Please explain it.

Your answer

What are your thoughts about reducing interference terms as hints to the player?

Your answer

If you encounter any confusion while playing Ice Sokoban, please write them here.

Your answer

If you encounter any a-ha moments while playing Ice Sokoban, please write them here.

Your answer

Do you have any more comments on Ice Sokoban?

Your answer
### Appendix C -

**What are your thoughts on DGDB in video games in general?**

| Group A |  
|---------|---
| 1 | It actually helps, for example some adventure or puzzle games can affect a player's enthusiasm and mindset if they get stuck on a stage for too long, but there aren't many games I've come across that have a DGDB-related system, and most of them don't make automatic adjustments for the most part.  
| 2 | it will make the game easier but in the same time the happiness from passing each level will decrease.  
| 3 | Helps the game slightly, but probably not very effective for most people.  
| 4 | I think it's necessary.  
| 5 | useful  
| 6 | Very balanced and very interesting.  
| 7 | Very helpful. Keeps it hard and fun at the same time  
| 8 | I think this system is helpful in terms of motivating players to keep playing.  
| 9 | effective  
| 10 | DGDB is helpful and will give the tips to complete the level.  
| 11 | Quite useful. Can improve the experience without giving up because the game is too hard.  
| 12 | I think they are good to have in puzzle games. I've heard that a lot of games have DGDB implemented but I don't really feel the presence of DGDB when I play them.  
| 13 | Invisible help and for the advancement of the game  
| 14 | It's good and can help player's pass more easy  
| 15 | It is very important and it can help player reduce the difficulty of the gameplay and build up their confidence to continue playing the game.  
| 16 | The good thing is that you can do it yourself without having to look up cheats, and it does not matter what kind of system you have. The bad thing is that it can spoil the experience for hardcore players.  
| 17 | This system is a help to players. It can better help players who wish to finish the levels faster to do so. At the same time the lower difficulty level prevents players from getting stuck in one place for so long that they lose interest.  

| Group B |  
|---------|---
| 1 | For those who like to play puzzle games, getting stuck on a level for a long time can be challenging and fun, but for those who are not used to playing puzzle games, getting stuck on a level for a long time can exhaust your patience until you uninstall the game.  
| 2 | It can be a little bit. But just a little. Otherwise, there's no gaming experience  
| 3 | It’s clever, it’s flexible, it allows the player to adapt more to the pace of the game, but for some players who like a challenge, it can detract from their experience.  
| 4 | It’s okay not to hint at a certain time. Targeting demographics makes for a different game experience. Adults don’t need it, but children do.  
| 5 | It’s necessary, without this adaptive mode the game will lose a lot of players, most of the players who don’t need the adaptive mode are hardcore players who have played a lot of games and are very skilled. For them, keeping the difficulty level the same is fun, and they
can analyses and compare themselves within their own gaming community. However, for the less experienced players, an adaptive mode can help them continue to immerse themselves in the game and retain players while they have fun solving the game. Kill two birds with one stone, win-win LOL

6 It will make the game less interesting

7 it depends on different players

8 It’s fine for low-end gamers. Hardcore gamers don’t need it.

9 It’s a system that can be made to reduce frustration as much as possible, but the timing and frequency of its appearance needs to be carefully adjusted to avoid destroying the player’s desire for challenge (those that do: random cubes in level-based Mario, help mode alerts in Mario Odyssey; those that don’t: the various difficulty options that come with the game but don’t give any indication of what’s going on). But Resident Evil 4 or Zelda's dynamic dropping of resources feels fine

10 It is necessary, but the time to hint the player, the degree of hinting the player needs to be more appropriate in order to enhance the player's experience!

11 It would be good to use DGDB if the difficulty strongly affects the flow of the gameplay. For example, if there would be one level that is so difficult that people quit that level. If it is challenging enough and not confusing, it is not really needed.

12 It’s helpful for casual players to adapt in the challenging levels and to bring players into mind flow more quickly.

13 First of all, I don’t like the system, but the system makes sense.

14 I am not personal fond of the system, but in some case, it is a good way to balance different players.

15 Generally, DGDB is a good concept. However, personaly speaking, I only encounter DGDB in not many games (Metal Gear Series, some Roguelikes) The DGDB system should be given a switch determined by players to turn on or off

16 From my perspective, every game's DGDB is important system in game, it can give novice players a better game experience. Whether it is a novice player or professional player. This system controls the balance of the game.

17 I don’t think it’s very well noticed and it detracts from the communication between the player and the game.

Do you think it's necessary for puzzle games to have a DGDB system that helps players complete the game? Please explain it.

**Group A**

1 I think the DGDB system is needed but not necessary for puzzle games, because the types of players are different, because the points of interest are also different, some players who may not often play/are not good at playing puzzle games in the process of trying if there is a DGDB system can help them to explore the game more closely; for the players who are enthusiastic about the puzzle game, the DGDB system may play a relatively counterproductive effect.

2 I will think it depends. if it is a puzzle game designed for child, the main purpose will be led the child to think more and re-plan each move. The DGDB will be a good sign to change the thinking of the child player in time. it will also save the time spending in each level. But if it is a normal game for everyone, i dont think it will be a good option. Player in this kind of game will be happy to make some record. DGDB is not that fair.

3 Of course. I probably wouldn’t have finished the game without this system

4 I don’t think it’s necessary. For developers, it might add to the game time. I don’t want hints, so I don’t think I need them.
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<tbody>
<tr>
<td>5</td>
<td>yes, because some people just don't get the point solve it</td>
</tr>
<tr>
<td>6</td>
<td>Yes, it's very friendly for slightly less logical players, and for highly logical players it adds to the fun.</td>
</tr>
<tr>
<td>7</td>
<td>Very necessary. Because it will show you the way when you've tried to give up so many times!</td>
</tr>
<tr>
<td>8</td>
<td>It is necessary, and without it, one may proceed to the point of giving up or repeatedly wasting time in a wrong direction.</td>
</tr>
<tr>
<td>9</td>
<td>It does help players to reduce the wrong path</td>
</tr>
<tr>
<td>10</td>
<td>Yes, as it will give confidence to players while they are stuck with one level.</td>
</tr>
<tr>
<td>11</td>
<td>Necessary. In general, indirect hints are good for improving the player's experience. If the clues are given directly, it greatly undermines the player's confidence.</td>
</tr>
<tr>
<td>12</td>
<td>I think it's necessary to have them in hard levels. Having DGDB doesn't necessarily take off the feeling of achievement when I solve the puzzle with its help. On the other hand, stuck in a level for very long can be frustrating.</td>
</tr>
<tr>
<td>13</td>
<td>This is necessary, otherwise players can easily get into the wrong mindset and take the bull by the horns, resulting in blocked progress.</td>
</tr>
<tr>
<td>14</td>
<td>yes, because it can give some new idea for player</td>
</tr>
<tr>
<td>15</td>
<td>Yes. If I found a level is too hard to play, I will just give up this game: x</td>
</tr>
<tr>
<td>16</td>
<td>I think it's necessary. I don't play many puzzle games, but human patience is limited, and if the difficulty is too high and cannot be solved, the game will be abandoned. If there is such a system in the puzzle game, the player can have the motivation to keep playing, and indirect hints will not affect the player's self-confidence, but can also inspire the player to complete the game on his own, so that he can feel a sense of satisfaction.</td>
</tr>
<tr>
<td>17</td>
<td>I think we should have it but it's up to the players to decide whether to enable it or not.</td>
</tr>
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**Group B**

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<tbody>
<tr>
<td>1</td>
<td>It should be placed in the settings as a controllable option that players can customize to turn on or off.</td>
</tr>
<tr>
<td>2</td>
<td>Necessary. If you don't know how to play, you don't</td>
</tr>
<tr>
<td>3</td>
<td>I don't think it's necessary. The core of decryption is that it has a fixed difficulty.</td>
</tr>
<tr>
<td>4</td>
<td>Not. Puzzle games are usually played without hints, and the harder they are the more challenging they are</td>
</tr>
<tr>
<td>5</td>
<td>Yes, with puzzles, the goal of the game designer is to keep the player playing, playing to the end, and playing for a long time. This mode not only prevents players from falling into self-denial, but also prevents them from losing confidence and giving up because they haven't completed the level for too long!</td>
</tr>
<tr>
<td>6</td>
<td>Non-essential, but should be given a few tips</td>
</tr>
<tr>
<td>7</td>
<td>No DGDB is better at the start when the game is public at moment, gives a great sense of accomplishment to the players who finish the game firstly. and as a puzzle game, obviously DGDB system is an act of compromising with the players who don't like challenge, that's the opposite of what a puzzle game is supposed to be about.</td>
</tr>
<tr>
<td>8</td>
<td>It's still better to add a little if you need it. Getting stuck can be hard, a little hint would be good for the mind. Watching adverts for hints is fine, but keep it short.</td>
</tr>
<tr>
<td>9</td>
<td>Unnecessary, try not to do it. Puzzle games are a two-way game between the player and the level designer; the player will want a constant upward challenge rather than a downward one, and the level designer must be confident enough in his level design and pace of choreography. Trying to make the rhythm of the level as smooth as possible, although it may</td>
</tr>
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</table>
not be on the airwaves, but the designer should not be easily thrown to the player's puzzles to become lax, by certain ways to allow players to take the initiative to get hints or adjust the difficulty, I personally think this will be relatively less destructive to the flow of the mind!

It is necessary. For example, Tomb Raider's puzzles have used hints after the player has been unable to solve them for a long time; God of War series puzzles have in-game character voice hints after the player has been unable to solve them for a long time, etc.

I don't think it is necessary to use DGDB in puzzle game, as long as the mechanics are clear. Puzzle games are meant to stimulate your brain to come up with the solution to solve the problem.

It depends on the design of both game difficulty and instructions. A game with higher difficulty and fewer instructions relies on a DGDB system more obviously than a game with lower difficulty and more instructions, which is specifically suitable for puzzle games.

It's necessary. Because not everyone wants to spend a lot of time and effort decoding it, it's a fun thing to do.

I do not think so, DGDB seems to be a system to balance different players and makes the game process smoother. There are a lot of other ways to achieve the same purpose, such as alternative hints, through which players can subjectively change the difficulty, rather than being forced to make any adjustment.

No. Puzzle game should be a intellectual challenge which holds a extreme difficulty level based on the developer's designing purpose.

I think it needs to be divided into whether it is a professional game or a novice player who has just started the puzzle game.

There is a need, a great need, to give the player some hints, otherwise none of the players will be motivated to play, and I crave encouragement in the game, and such encouragement may come from the fact that I managed to solve the puzzles after giving the hints.

What do you think about the DGDB in Ice Sokoban?

Group A

1. I wasn't aware of the DGDB system in the first few levels until one of the moving ice cubes on my screen suddenly disappeared, and I realized that the game was gradually reducing the number of paths to help the player find the right one. And due to Ice Sokoban, the requirements for the sequential steps of the game is relatively strict, to a certain extent, the DGDB system does effectively influence and hint the player how to continue; on the other hand, in the discovery of the existence of the DGDB system in the game, when the heart will also have a little secret reassurance, it feels as if for the time being can't be solved, it doesn't matter if you can’t try to get out of the little hints will be given.

2. Good, it is good mechanism to help player don’t give up. But to be honest, I am not that happy when i passed by DGDB. I have already spent more than half hour to figure out the answer. I want to pass by myself and compete with my friend for the record.

3. Helpful in thinking about how to proceed next, but not very effective.

4. I didn't have the time or inclination to notice.

5. its really useful

6. It's so well hidden, it makes it seem like every plate appears as if it's there for a reason.

7. DGDB helped me eliminate wrong answers in some levels.

8. In this game, he helped me sift through what I thought was the right direction, but was actually the wrong one, and pulled me out of the bull's-eye to avoid wasting time indefinitely.

9. necessary
| 10 | It is interesting, immersive, challengeable and also has difficulties for players to solve. |
| 11 | It's pretty good. It was helpful for me to troubleshoot the wrong path. |
| 12 | I think I notice one time when DGDB kicks in and it did guide me back to the right direction to solve the puzzle. I like the feeling. It's like those options to remove a wrong answer in those tv game shows. However, in the final level I was stuck for very long but the DGDB didn't seem to step in. I'm interested in how it is implemented. |
| 13 | Helps me and is not easily noticeable Benefits: does not undermine the player's self-confidence and helps the player by removing some of the misconceptions. The bad: in a way reduces the difficulty, the player is unable to experience the game perfectly and completely and test himself. |
| 14 | not very well |
| 15 | Good. Otherwise, I cannot pass level 17. And it is very friendly, not very obvious and leave a space for thinking. |
| 16 | It's pretty good, I didn't even realize that I was doing it without realizing. But not sure when the hints were given and still interesting |
| 17 | This is a good attempt to combine a classic game with this system. It doesn't take away from the fun and helps some players to get through the levels and feel the joy of deciphering. |

**What are your thoughts about reducing Interference terms as hints to the player?**

**Group A**

| 1 | In fact, the initial discovery of the lack of ice can feel a little strange at first, even a little suspicious of your own memory: "Was there a road here before or not? Was it a system error?" That sort of thing. However, the reduction of obstructions is not a direct hint, and the so-called "hints" have a more obvious difference, in the end, or players need to think for themselves, and will not directly point out the road or give a clear direction, in the hints at the same time still maintain the difficulty of the game as well as the fun, I think it's very good. |
| 2 | For me, it is not good, i have already made the plan to complete the level. but when the interference lost, i felt confused with what i have done in last 5 mins. According to the final result, it definitely help me to pass the difficulty. Nonetheless, I lost some achievability from the puzzle game. |
| 3 | Quite necessary, will avoid a lot of wrong direction of thinking |
| 4 | I think everything on the field should play its part and therefore may influence my judgement. |
| 5 | that's interesting design |
| 6 | It's a good thing, because it allows me to eliminate a lot of incorrect path choices. |
| 7 | I think it's better to give proper hints, it keeps the player engaged but not frustrated |
| 8 | I think it's a better way to give the player some hints to get through the game, and the player still needs to think hard to get through the game even after being hinted at, even though I didn't realise the system existed at some point. |
| 9 | It's not easy to perceive. |
| 10 | Reduces the sense of accomplishment, makes me look stupid, but does help me cut down on a lot of wrong thinking and complete the level. |
| 11 | Very reasonable. It's a very logical way to help me eliminate wrong answers in time and prevent me from thinking in the wrong direction all the time. Being stuck for long periods of time can lead to low moods, but hints like this can help me find the right direction quickly and improve my gaming experience |
I think that is a really nice approach. It's not telling me the right answer but helping me narrow down the options.

For this game, that choice is a near-perfect way to hint.

It's ok but needs improvement, like the labelling of hints or the appearance of a line reminding the player that the system has been used.

Good. I think it cut down my useless ideas and let me get close to the solution. It is improving the gaming experience of players... at least, I am not upset when I recognized I cannot slove the puzzle xD

Quite good. The indirect cues are cleverly used to preserve the player's gaming experience and self-esteem.

Some hints can be difficult to feel because the player is so immersed in the game. But unknowingly reducing the difficulty is a great way to do this.

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<th>Group B</th>
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<td>14</td>
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<td>15</td>
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<tr>
<td>16</td>
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<td>17</td>
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If you encounter any confusion while playing Ice Sokoban, please write them here.

VI
Group A

<p>| | |</p>
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<tbody>
<tr>
<td>1</td>
<td>(Only in the beginning, maybe 12 levels and before) is where the ice stops sliding, from the front level it is clear that the ice stops sliding on the lawn, but the ice also stops sliding when it is pushed out of the lawn, which makes me think about whether it is the ice pushed out of the lawn that stops for a while, or the ice around the lawn that also stops, I remembered that there seems to be a front-level tutorial on this mechanic, but I didn’t pay too much attention to it, and only really figured it out after trying it more and more while stuck in levels I couldn’t get through.</td>
</tr>
<tr>
<td>2</td>
<td>Good Good Good. no doubt i could be a TOP1 game in every game platform you published.</td>
</tr>
<tr>
<td>3</td>
<td>no</td>
</tr>
<tr>
<td>4</td>
<td>Nope</td>
</tr>
<tr>
<td>5</td>
<td>too difficult for me</td>
</tr>
<tr>
<td>6</td>
<td>no</td>
</tr>
<tr>
<td>7</td>
<td>nah</td>
</tr>
<tr>
<td>8</td>
<td>No</td>
</tr>
<tr>
<td>9</td>
<td>NONE</td>
</tr>
<tr>
<td>10</td>
<td>no</td>
</tr>
<tr>
<td>11</td>
<td>no</td>
</tr>
<tr>
<td>12</td>
<td>I think I understand the mechanics pretty well as the game progresses.</td>
</tr>
<tr>
<td>13</td>
<td>There’s no way to adjust the bgm.</td>
</tr>
<tr>
<td>14</td>
<td>Yes. The game is still a bit stiff then there are a few levels where the view of the ice isn’t very good</td>
</tr>
<tr>
<td>15</td>
<td>Not really. I think figure out the rule during playing simple levels is very fun.</td>
</tr>
<tr>
<td>16</td>
<td>Could do with an undo, not being able to go back to the previous step kills me, I have a bad memory not being able to remember the path I’ve taken before.</td>
</tr>
<tr>
<td>17</td>
<td>The ice is somehow difficult to identify. For example, the colour of the ice on the snow and where the sea and ground meet the ice can show incompletely.</td>
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Group B

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<tr>
<td>1</td>
<td>NO</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>nope</td>
</tr>
<tr>
<td>4</td>
<td>NO</td>
</tr>
<tr>
<td>5</td>
<td>I CANT SEE THE ICE CUBE IN THE CORNER!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!</td>
</tr>
<tr>
<td>6</td>
<td>no</td>
</tr>
<tr>
<td>7</td>
<td>no</td>
</tr>
<tr>
<td>8</td>
<td>The first 10 levels are easy, then the difficulty ramps up, and it’s a bit disjointed.</td>
</tr>
<tr>
<td>9</td>
<td>Basically no, but there are distractions in the early and mid-levels that make me take the puzzles in a complex direction</td>
</tr>
<tr>
<td>10</td>
<td>nope</td>
</tr>
<tr>
<td></td>
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<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>11</td>
<td>Only the bug in some levels where the water will cover a piece of the level. This will make it a bit harder to see what you have.</td>
</tr>
<tr>
<td>12</td>
<td>At the beginning I did have some confusion but soon it disappeared. This game has a great difficulty curve.</td>
</tr>
<tr>
<td>13</td>
<td>Basically no. Thought everything in the map was going to be used.</td>
</tr>
<tr>
<td>14</td>
<td>None.</td>
</tr>
<tr>
<td>15</td>
<td>Too high difficulty</td>
</tr>
<tr>
<td>16</td>
<td>No</td>
</tr>
<tr>
<td>17</td>
<td>No, it's just too hard for me.</td>
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If you encounter any a-ha moments while playing Ice Sokoban, please write them here.

**Group A**

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<tr>
<td>1</td>
<td>Yes. Usually when I've been stuck on a level for a while, or a long time, and after some brainstorming or trial and error or even with a bit of unexpected luck, I finally solve the level. But levels 14-16, for example, are the more difficult levels in terms of level order, but since I haven't been stuck for very long, the feeling of joy and relief when I solve them is relatively poor.</td>
</tr>
<tr>
<td>2</td>
<td>no</td>
</tr>
<tr>
<td>3</td>
<td>On the last level, a change in the order of operations caused me to have a sudden epiphany!</td>
</tr>
<tr>
<td>4</td>
<td>Yes, it can be very rewarding to pass and want to see how fast you can do it.</td>
</tr>
<tr>
<td>5</td>
<td>nope</td>
</tr>
<tr>
<td>6</td>
<td>yes the level 14</td>
</tr>
<tr>
<td>7</td>
<td>But I feel joy in that moment when I suddenly find a way to pass the level after many tries</td>
</tr>
<tr>
<td>8</td>
<td>There is when you are about to pass before.</td>
</tr>
<tr>
<td>9</td>
<td>encounter when completing hard pass</td>
</tr>
<tr>
<td>10</td>
<td>Level 14 I was surprised when I realised there were only three targets but four ice cubes.</td>
</tr>
<tr>
<td>11</td>
<td>Yes, during the last level and at the moment of passage</td>
</tr>
<tr>
<td>12</td>
<td>There was one moment in one level when I realized I should make the cubes into a complex shape beforehand and then push it to the destination and have the bonfire remove the unnecessary cube. I think that's a neat way to thinking about the solution.</td>
</tr>
<tr>
<td>13</td>
<td>On the penultimate level, a lack of calmness in analysing at first led to advancing the game directly by trying various moves, but inefficiently. Afterwards, calming down and choosing to first analyse each ice block's possible routes of travel in order to circumvent impossible moves after two attempts it was passed.</td>
</tr>
<tr>
<td>14</td>
<td>Yeah, like level 17.</td>
</tr>
<tr>
<td>15</td>
<td>When the hint came out and I found out my thinking way was wrong. When I found out the &quot;useless&quot; cube is the key to solve the quest.</td>
</tr>
<tr>
<td>16</td>
<td>Yes, it has been found that several ice cubes can fit together and have friction, and that ice cubes can put out fires.</td>
</tr>
<tr>
<td>17</td>
<td>I really like level 16. The design is fantastic!</td>
</tr>
</tbody>
</table>
Not all fires have to be put out, and not all ice has to be used.

Yeah, when I got stuck, I suddenly understood the game mechanics.

Yes, it was. Especially in the later levels, it dawned on me that this is the way it should go.

I started looking for permutations of the same shapes as the end squares.

There are a few, and there's a level that's passed very much by luck, not by thought, that will be marvelled at.

I think there is a lack of it for now, and it would be a plus if it was there, but it doesn't matter if it isn't. I myself would expect some interesting a-ha moments outside of the gameplay, a-ha moments when old and new mechanics occur in combinations that exceed expectations.

The first few levels gave me an a-ha moment, when each level slowly introduce me a part of the game mechanics.

It took me more than 20 minutes to solve level 14 and 17, but it was so exciting for me to work them out without hints given.

Yes. The moment I knew the answer.

When the iceberg was pushed to the ice from the grass, it will only go one grid ahead.

There was, when I learnt that fires can be extinguished, that ice stops when it meets grass, and that ice can be connected.

After I found out that the game has a DGDB system, I’ve been trying to minimize the number of trial and errors, I’ve been doing calculations in my head, and I don't restart even when there are levels that are clearly incorrect and impossible to complete, because I haven’t played very many puzzles myself, and I'm passionate about puzzles myself, so I don’t particularly want help from the game, such as hints/DGDB system, but this comes from my own confidence and self-esteem in my ability to solve puzzles, and not all players have the same mentality. I don't particularly want help from the game, such as hints/DGDB system, but of course this comes from my own confidence and self-esteem in my ability to solve puzzles, and not all players have the same mentality. Although I did find it nice to have the DGDB system when I was stuck for a long time or even when my mind exploded a little bit, I still wish there was an option for it, after all, part of the puzzle game audience would prefer to solve harder puzzles with their own abilities. :>

Some ice and grass land graphics could be better. and it could be a timer or each level record on top left. and there could be an introduction page before level one which describe the fire, ice or grass land could do. I do think it should be a good game for child. and the element in each level could be more.

I can’t see that ice block on a certain level. i still don't understand the way to pass level 14.

I wish there were more levels and more scenarios.
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<tbody>
<tr>
<td>5</td>
<td>NOPE</td>
</tr>
<tr>
<td>6</td>
<td>please add more level</td>
</tr>
<tr>
<td>7</td>
<td>The game has a classic format but adds many innovative mechanics and players need some time to think before they can pass the level. Overall, very original and very entertaining.</td>
</tr>
</tbody>
</table>
| 8 | 1. I think you can add "Give each ice cube a serial number" to the clues.  
2. I think after passing it you can automatically go to the next level without having to click manually" |
| 9 | NONE |
| 10 | Good |
| 11 | Pushing on ice and grass sounds the same. You can change it to something different. |
| 12 | It's a intense and fun game. Thanks for making it! |
| 13 | So genius, looking forward to a sequel. The difficulty level is suitable for most beginner puzzle game fans, optimizing the classic puzzle game with a fun new design and some new settings. |
| 14 | Need to further improve character movement and animation fluidity. |
| 15 | Very nice! And I think the hint can be came out more quickly xD |
| 16 | No need to manually proceed to the next level just to make a big logo appear after success |
| 17 | Excellent game and I would love to keep trying if more levels were released. But optimisation of the item materials and voice acting could make this game even better. |

**Group B**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>no more</td>
</tr>
<tr>
<td>3</td>
<td>It's a very complete game, and there's nothing wrong with its level design.</td>
</tr>
<tr>
<td>4</td>
<td>This game is not very difficult. The music is optimised to give the player the feeling of playing a puzzle game.</td>
</tr>
<tr>
<td>5</td>
<td>IT IS FUCKING AWSOME, I WANT TO LET ALL MY FRIENDS TO PLAY AND BEAT THEM SO HARD. It will be great that the game will have the timer and in the end of the game, will have a dashboard to tell you how much time you spent in each level.</td>
</tr>
<tr>
<td>6</td>
<td>Characters move stiffly.</td>
</tr>
<tr>
<td>7</td>
<td>the game is clearly lacking in CHARGE</td>
</tr>
<tr>
<td>8</td>
<td>The game should tell the player where the destination is. Cons Moderately difficult levels.</td>
</tr>
<tr>
<td>9</td>
<td>I want more a-ha moments and relatively smoother pacing of the levels</td>
</tr>
<tr>
<td>10</td>
<td>no</td>
</tr>
<tr>
<td>11</td>
<td>Nice game, it was fun to play.</td>
</tr>
<tr>
<td>12</td>
<td>It has astonishing degree of completement, so I don't have any suggestions.</td>
</tr>
<tr>
<td>13</td>
<td>Basically no</td>
</tr>
</tbody>
</table>
| 14 | 1. There should be a hint button to remind the player whether the current game has come to an end (there is no way to accomplish the goal).  
2. It will be better to have a single step back option. |
<p>| 15 | Too high difficulty for casual players |</p>
<table>
<thead>
<tr>
<th>16</th>
<th>it is very perfect arcade game, and there are very few bug in the middle. Anyway, it is a very suitable game to play in leisure time.</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>A big sign of success would be great, I need to be encouraged! Need the visual impact!!!</td>
</tr>
</tbody>
</table>