GAME-BASED LEARNING TO RAISE AWARENESS ABOUT WATER SUSTAINABILITY

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In this paper, we discuss the development of an engaging game "Full Tank", designed to sensitise students about water usage and preservation. We present an overview of the game and discuss the process of designing educational games using an endogenous game design approach. The game is inspired from real life scenarios which were then carefully converted into game elements, player interactions and game mechanics. Lastly, we discuss the game "Full Tank" in the context of developing another game titled "Gram" which is also aimed at sensitisation towards water conservation and usage at a community sharing level.

INTRODUCTION

Awareness about climate change, water security and biodiversity are among the various important and recurrent topics that are taught in the Environmental Sciences (EVS) classes in Indian schools. The topics are detailed out as students progress from primary to secondary school years. Specifically, under the theme of water, the school textbooks cover a range of issues like sources of water and its storage, water at homes and communities, drinkable water and its supply, etc. These topics are usually taught in schools using textbooks, lectures, documentaries or student activities. One can also find lesson plans and web-based games around this theme like 'One for All: a natural resources game', 'Name that resource', and 'Eco' (One For All: A Natural Resources Game, 2014; Activities to Help Kids Learn About Natural Resources, 2019; Eco, 2018). However, one may argue that infrastructure dependent games, be it physical or web based may not necessarily have a wide reach in India, owing to many reasons. Further, many of the existing games are easy to play for an older audience who are equipped with resources, both physical and technological. Lastly, the integration of domain-specific learning into play-based activities and games is not common and remains a challenge for educationists.

BACKGROUND: THE PROJECT AND CONTEXT OF THE GAME DEVELOPMENT

The game design case studies discussed in this paper come under the ambit of a longitudinal participatory action research project called School Science Research and Development (SSRD), involving a local school, its teachers, and students (Deshmukh et al, 2018). This project involves working closely with teachers all year round to develop lesson plans around the environmental science (EVS) and general science curriculum and supplement classroom sessions with fun, inquiry-oriented activities and worksheets, among many other methods. In this context, the focus of our project was to develop an engaging game based on design principles for the topics taught in Environmental Sciences.

Textbooks, lectures, documentary screenings, special camps and workshops are few of the common modes in Indian classrooms to teach about the water crisis and other environmental concerns. This is supplemented by co-curriculars like project competitions, debates and art/theater which also give students an opportunity to express their thoughts on the topic. Although, the intent of the textbook activities is to generate interest in the students and aid better understanding of the topic, there seems to be a gap. On one hand the textual content equips students with necessary information, but there are limited activities linked to real life experiences. Therefore, while the textbook chapters covered water related themes at a broad level, there was scope to introduce the same issues using more locally relevant examples with a playful approach. This presented an opportunity to design engaging activities through the use of contextualised games which can help students observe, record and reflect on their immediate surroundings. The motivation behind the game design thus was to bring awareness, provide a valid connection with the curriculum and extend classroom learning in a playful manner.

GAMES AS A MEDIUM OF LEARNING

Games are often described as organised play that is structured by a set of predefined rules and an obstacle-tackling goal (Klopfer, Osterweil & Salen, 2009; Schell, 2008). This hypothetical goal is designed in an artificial environment where the players willingly submit to the game rules, knowing that their gameplay and player interactions may result in success or failure. Research has often highlighted the importance of play and games in learning (Granic, Lobel & Engels, 2014; Cooper, 2014). Moreover, when interacting with young children, play-based (Vygotsky, 1978) interventions, activities and games tend to captivate them and direct their attention to the concerned issues (Malone, 1981; Sedig, 2008). Games as a medium of learning have the potential to allow for accommodating complex information, breaking it down into game elements, presenting the content in the form of a plot, and challenging tasks and rewards associated with player actions. Game-based learning has been reported as beneficial for students not only from a learning perspective but also from the point of view of developing integral skills and attitudes such as risk-taking, accepting failures, healthy competition, tackling uncertainty and problem-solving (Klopfer, Osterweil & Salen, 2009).

Designing an educational game can be challenging as compared to casual games as it has a cognitive learning goal or attempts to attain a certain behavioural change. The rapid advances in the edutainment industry and in the development of learning games may at times overlook the contextual learning-play integration and may inadequately coat the educational content with superficial game-like elements and present it as play-based learning. In the domain of serious and purposeful game design, such addition of game-like elements is known as chocolate-coated-broccoli (Habgood and Ainsworth, 2011). The range of game-elements commonly include non-contextual use of characters, labels and cosmetic visuals coated on top of popular games such as Snakes and Ladders or Monopoly without altering the game play and structure. Studies on purposeful learning games have emphasised the need for appropriate integration of learning content and game play (Ke, 2016). While designing purposeful games, game designers consciously direct the actions of players and player interactions with the hope of initiating a subconscious behavioural change.

Endogenous game design is a category of designing purposeful games where the game play emerges from the content to effectively integrate learning with play. Very often, in education, we see learning content being gamified with superimposition of unrelated content on gameplay (Athavale & Dalvi, 2019). The design approach of endogenous games is in harmony with the learning content, and this is what makes this game design effective. The gameplay makes

learning and playing go hand in hand (Malone, 1987; Habgood and Ainsworth, 2011). An attempt towards an endogenous game design approach is taken by referring to the state board curriculum textbooks to develop play-based learning activities on chapters from the Environmental Studies textbooks. In the process of designing games, unique aspects of the topic of water distribution were studied and translated into game elements and mechanics.

OVERVIEW AND DESIGN OF THE GAME 'FULL TANK'

As per the Maharashtra State Board syllabus (SCERT), EVS chapters in grades 3 to 5 include topics like 'Our need for water, Where does water come from, Storage of water, Water safe for drinking, Water for every household. During the initial school visits and student interactions, we observed that the textbook and other students' activities could be designed to accommodate student inquiries driven from their observations of their surroundings. This led to the conceptualisation of the 'Full Tank' game, aimed at enabling students to articulate and share their observations about water usage with their peers and teachers. It has been designed with an attempt to make students aware of how water is consumed in their immediate surroundings. The game is designed for 2-3 players in the age group of 8 to 12 years old.

Water tanks are used as a common storage option in many Indian households. The idea behind having a tank depicted as a representative scale, is to indicate that water though renewable is something that can become scarce and at times get exhausted. The scale tries to show that various human activities, as depicted in the 'Water Activity Cards' can have positive or negative effects on the water level. The daily chores/activities of the household are presented on cards with which the game is played, and alternative water usage options are given for the same chores. For instance, for a "Cleaning" task there are two options provided, one which results in water wastage (using a hose/pipe) and the other which helps in using less water (using a mop). Thus, water consumed while doing various activities affects the water level on the water tank. These fluctuating water levels in turn gives an opportunity to the players to assess which activity may preserve or waste water. The elements of the game are discussed below (Figure 1):

Figure 2: Game board (left) and water activity cards (right) of the Full Tank game.

The water tank scale- A measuring unit for water (0L till 180L) used as the game board to play on and to depict the water levels for each player. This range was chosen as an optimum figure based on the number of water activity cards and the rise/fall values assigned to them.

The water activity cards- The content of these cards was derived from everyday practices which involved water usage, which may either result in conservation or wastage of water. The identification of these chores was a combination of both brainstorming over common practices

and extension activities provided in school textbooks. Through these activity cards, situations in which water is typically consumed in different quantities have been gamified and described in a playful manner. This in turn affects the water in the water tank scale. There are additional Do-It-Yourself (DIY) cards provided for students to observe their surroundings, write new water related activities and their usage on the playing cards and use those cards to play. The game thus has an aspect of novelty, personalization and scalability.

Each activity card has the following information on them: Type of activity - which uses water; Specifics of activity - in which context an activity is carried out; Litres of water used in this activity; Fall/Rise of water in Water Tank Scale due to this activity; Reason behind the Fall/Rise of Water.

Markers - A marker for each player that shows the rise/drop of water in a water tank.

Game Play: Players represent themselves with unique markers on the game board. All the players start at the middle of the water tank, from where they can either move up or down as per the activity cards. Each player picks one activity card in turns and accordingly places the marker on the water tank scale. This playful approach behind the rise or fall of water on the tank, grounded in real life situations, is the main mechanic in the gameplay.

End of game: The game ends when a player reaches '180L' or '0L,'. But if no one reaches 180 or 0 even after the cards are consumed for the second or third time, then the player who is at the top of the water tank scale wins.

Figure 3: Playtesting of Full Tank game with middle school students in Gujarat.

The game was play-tested with students with minimal facilitation. They were informed about the rules of the game and that the game is based on their surroundings and water consumption. It was observed that they enjoyed playing the game together. They liked the simplicity of the game, the fact that two approaches of water usage for the same purpose were shown on the cards and accordingly they got to move their markers up and down on the tank scale. This made them aware that being water-conscious is important. The initial rounds of testing (Figure 2) also revealed that the students only played to win and focused on the movement of markers based on the value of litres written on the cards. They often ignored the information given on the cards and the relevance of water consumption in various situations. They also did not pay attention to the reasons for the rise/fall of water in the tank. Post-testing certain changes were made in the game play. Now, the revised rules required players to pick one card at a time and read aloud the water activity and the specifics of the activity. The others have to guess if the marker would rise or fall on the water tank scale. Players then read out the rest of the card and accordingly move their marker up (rise) or down (fall). This additional interaction between the students provided little more engagement, peer interaction and learning. Since play testing also indicated that the game did not necessarily finish with one round of playing, reshuffling and reusing the cards was introduced. In the revised rules, reshuffling can take place at a maximum number of 2 (for two players) or 3 times (for three players). At this stage, the players did not design any

new cards to play with. Instead, they played with the set provided to them. The teachers can probably intervene here and encourage students to observe their surroundings and help them to design their own cards to make the game more contextual. The latest version of the 'Full Tank' game can be accessed on the Design and Technology Education group's website: https://dnte.hbcse.tifr.res.in/lab-activities/

SUMMARY

The objective of our project was to look at alternative media to aid active learning, engagement, and play-based learning methods for maximum student participation. Water forms a very important topic in the Environmental Sciences and science textbooks from lower to higher grades. The game "Full Tank" is an attempt to introduce the issues related to water conservation in one's surroundings through play. In the game, students need to pay attention to their surroundings and identify ways in which water is being wasted or conserved. As the game is played, it is hoped over time, students will realise that these small conservation efforts when implemented at the community level contribute significantly to safeguarding this life-sustaining natural resource. The most important feature of the game is that there is an option to make your own 'Water Activity Cards', so that players can bring in local experiences and add them to the game in their local languages, thereby enhancing engagement and the scope of the game. Some of the possible skills students may develop by undertaking this card-making exercise include, observation of surroundings, problem identification, looking at issues from multiple perspectives, communication and collaboration.

WAY FORWARD AND AN OVERVIEW OF THE GAME 'GRAM'

The understanding of water as a resource broadens from an individual's consumption to community sharing and distribution, as one moves up from the lower to higher grades. Details such as different sources of water, its ever-increasing consumption and distribution systems are elaborated. Building on the basics of community sharing of water, cooperation, and water sustainability, another game titled" Gram" (meaning society/village) has been conceptualised where a hypothetical village is to be provided water and the challenge is to make the village water distribution efficient via players cooperation and strategy. The elements of the game (Figure 3) are discussed below:

Figure 4: Game elements of the "Gram" game

Game elements and gameplay: The game consists of 15 colony cards and 30 water cards. The colony card depicts the occupations that are practiced in villages namely markets, agriculture,

transport, handicrafts, healthcare etc. and shows the number of families dependent on that occupation. The water card shows the type of water source that can provide water to the village. These can vary from natural sources like rivers and lakes to human-made sources such as dams, overhead tanks, wells, borewells and tankers that cater to water demands of people. The selection of colonies and distribution of water within the resources is inspired by real life scenarios. Players must divide themselves into 3 teams. Each team may have 2-5 individuals. The colony cards and water cards are distributed equally amongst the three teams. Following certain rules, each team has to organise their cards by linking water cards for each colony card such that it best meets its water demand. Once this stage is achieved by all the teams, the teams work together as one unit and ensure that the water requirements of the other teams are also satisfied. This cooperative effort to satisfy water needs of all the teams is referred to as playing together as a 'Gram'. In this advanced stage of the game, the decisions by the team with the most water resources of the Gram will decide the outcome of the game. If played this way, the game will finish when 3 teams together reach the best possible solution to address their water requirements. On the other hand, if a Gram has more than seven colony cards that are water deficit, then this ends the game. This reflects the poor water situation of the Gram.

User testing and evaluation: The game is currently in the evaluation stage and is being play tested with secondary school students (Figure 4). The principles and dynamics of the game are unique for Indian classrooms and need careful testing and analysis for it to be an effective learning aid for students.

Figure 5: Paper prototyping the game 'Gram' and testing with students.

DISCUSSION

In this paper, we discussed game-based learning and the process of game design based on effective learning-play integration. Full Tank is a simple game focused on everyday usage of water. The game tries to bring to the fore small actions by individuals that either lead to water wastage or water conservation. The visual metaphor of using a water tank as a game board and students observing the rise and fall of water was found to be an engaging and playful way to learn about water consumption. We are aware that, in reality, water conservation is not so simplistic and there are multiple factors that affect water usage. However, this game simplifies the issue for young children and aims to raise awareness about the connection between our actions and water wastage or conservation. On the other hand, the game Gram is more complex in its nature, theme, mechanics, and game play. It is a cooperative game where the focus shifts from individual actions to working together as a team towards a shared goal of making the Gram water-sufficient and facing the consequences of the actions taken together. The objective

of these games is to make students aware of how water fares in daily use in small households and in communities. In future, it will be interesting to observe how playing such games can influence students' current understanding of these environmental topics and bring about a certain behaviour change in them.

The games discussed in this paper are designed with the intention of having a larger reach as it will be available in English, Hindi and Marathi and because of its minimal dependency on resources. The design is frugal and scalable as both the games can be printed on paper, cut as per the instructions, arranged easily and played. The game mechanics are simple, based on real life situations and grounded in the information to be disseminated which can be adapted as per contextual needs.

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