Gamification in Plant Education for Children

[1]Mudra Nagda, [2]Parth Mehta, [3]Simranjeet Lamba, [4]Pratik Kanani

Abstract

Gen Z are true digital natives and as opposed to millennials and prior, they have grown up with ready access to phone screens in a constantly 'plugged in' concrete jungle environment. This has led to a crippled relationship with plants and gardening activities, which were rampant in generations prior to them (millennials, boomers). Since this age group is often non confident of keeping their plant alive, they often lose interest in the process of gardening, which requires patience. Our goal was to address this issue using gamification as a positive persuasive design method. Our research paves a way to use Gamification User Types Hexad Scale (GUTHS) in designing for societal change that begins at the grassroots. Many other sensors and monitoring systems for plants exist in the industry, but they are used for crops and farmlands. They are not designed with the purpose to persuade and motivate, which are imperative when our end users are young adults who have little to no connection with nature. Our research is unique as it regards gamification as a useful tool to use to curb the early steps of climate change, in a generation that has high motivation and purpose but low ability and trigger to do so. By using Gamification User Types Hexad Scale to personalize game mechanics, we attempt to design technology that can build a connection between plants and young adults. Our research finds that the 'Philanthropist', 'Free Spirit' and 'Achiever' user types are the dominant user types in children in the planting context.

Keywords: Child Psychology; Gamification; Human Computer Interaction; Plants; User Interface; User Experience; User Types

I.   Introduction

Plants and trees have had a long standing relationship with humans ever since the onset of agriculture during prehistoric times. The practice of planting and nurturing trees and plants as a part of horticulture is known as gardening. Gardening can be ornamental, useful, medicinal or therapeutic. Gardening is particularly a common hobby in the pre-millennials and the millennials. Gardens have a particularly positive effect on children [1]. However, since the post millennials or the Gen Z have been born with a smartphone around them, they are often unaware about gardening.

[1] *Dwarkadas J. Sanghvi College of Engineering, Mumbai 400056*

[2] *Dwarkadas J. Sanghvi College of Engineering, Mumbai 400056*

[3] *Dwarkadas J. Sanghvi College of Engineering, Mumbai 400056*

[4] *Dwarkadas J. Sanghvi College of Engineering, Mumbai 400056*

Some even fail to understand what part of a plant does a vegetable come from. In this paper, we attempt at designing a concept of an app that uses game mechanics to help children belonging to the Gen Z age group plant and take care of virtual trees so as to prepare them to handle living plants. The key to non commercial, purpose driven, positively persuasive gamification is in understanding the user and thus we use the Gamification User Types Hexad Scale to evaluate dominant user types and game mechanic preferences. The goal of the project is similar to that of the Tamagotchi, it is for the user to enjoy the experience of how to plant and nurture a plant by self.

1.1. Humans and Plants through History

Before the industrial revolution, humans depended upon their botanical knowledge for survival. They made equipment such as fibers, cloth, baskets, spears, arrows, baskets, utensils. Early humans had an understanding of plant life cycles, seasons, harvest periods and primitive knowledge of agricultural practices such as crop rotation. They also used plants for their medicinal properties, to treat wounds and even severe illnesses. Ancient Indian, Chinese, Unani and Egyptian texts describe the importance and use of medicinal plants. Plants were being used for over 4000 years as medicine [2]. Plants were not just used as a utility, but also used as inspiration in arts, literature and language. Plants have a social significance as well as a physical significance in human lives - they influence human culture as their dependency relationship with humans has evolved over time.

Before the industrial revolution, humans have depended on plants for their survival and daily activities. Clothes, fiber, baskets, weapons, utensils etc were made using plants. Agricultural knowledge is also associated with plants - plant life cycles, seasons, harvest periods, soil types and practices such as crop rotation. Further, plants were used in medicinal practices too, as demonstrated by the Ancient Indian, Chinese, Unani and Egyptial texts. They were also used as inspiration for art and literature.

While the benefits of large green covers, forests and trees are of common knowledge to us, houseplants also have a substantial positive effect on human wellbeing. Some of the notable benefits are as follows: improved air quality [3], lower stress levels [4], faster recovery from illness [5], higher productivity levels [6] and positive effect on mental fatigue [7]. The effects of houseplants have been studied especially with students and children. The experiment of covering 6% of the floor area with green plants in [8] induced feelings of comfort and friendliness in students, reducing misbehaviour and also reduced the number of sick leave days. In [9], the presence of plants again showed a decrease in the number of sick leaves as compared to the same situation without plants. Again in [10], which is similar to [8] showed that covering 2% of the classroom area resulted in feelings of wellbeing amongst students. Several studies, as demonstrated above and even others [11][12] document the importance of plant interaction in children's everyday lives.

However, since the industrial revolution, the relationship between humans and plants has been declining. In [13] Shoemaker fears that the concrete jungle environment of the present times has led to cutting off the direct contact we once had with plants and nature. Video games, phone screens, television and other gadgets have replaced daily

plant related activities such as gardening, pruning, landscaping, farming etc. The absence of this dependency will most negatively impact children and millennials. The relationship between adults and plants is largely correlated to childhood interaction with nature [14]. The quality of this relationship depends on the strength of the interaction during the adult's childhood - uprooting a plant to repot it would leave behind a greater sense of appreciation of plants in the adult's life.

1.2. Gen Z

In our research, we explore the relationship between plants and the youngest generation, also called the 'Generation Z' or 'Gen Z'. Gen Z is a group of kids, teens and young adults born between 1997 and 2012. In 2019, they are roughly 7 to 22 years of age. Having access to a smartphone from the time they were born makes people of this age group 'true digital natives'. Their lives are highly integrated with technology and they are constantly 'online'. They are more aware of cybersecurity and ethics but are also more receptive to smartphone addiction, which differs them from millennials [15]. This generation uses a wide network of social media platforms such as Facebook, Twitter, Instagram and Reddit that enable them to have a voice and discuss their opinions on everything from politics to mental health. It has been dubbed as the 'woke' generation as they practice activism on the go. One of the examples include 17 year old Greta Thunberg's school strikes against the climate change crisis. This group is larger than the millennials as of 2020.

As a result of this generation being constantly 'plugged in' and absent in the physical world, plants now have additional newfound benefits for this generation. The presence of plants in their homes encourages a slowness in their fast paced life and helps them engage in an hands-on experience with nature. Plants have been used in therapy successfully and even outside of professional therapy, they are called a 'cheaper form of therapy' [16]. Educational institutions are using technology for an interactive education of horticulture and plant life. [17] says that though children take time to learn about plants, they integrate plants into their everyday life easily. In a survey of 50 students, 90% of the students said that they would take up planting outside of that class. The same 90% stated before the classes that they would hire an agency to work on horticulture or landscaping if needed.

The older members of the Gen Z, 18 - 34 year olds, constitute a quarter of the American gardeners who spent $76.3 on lawn and garden retail sales in 2018, according to the 2019 National Gardening Survey. This age group's spending on plants has grown at a higher rate than any other age group since 2014. Social media plays an important role for these members of the Gen Z. Instagram in particular has become a community place for plant lovers and beginners alike. Gen Z have also found support and formed friendships from online plant communities on social media platforms.

A notable characteristic and strength of the Gen Z generation is their entrepreneurial nature. On noticing the absence of plant life in everyday life, several startups are modelled around selling houseplants and plant kits. We discovered that while the demand for buying plants is high initially, customers often worry about how to take care of it to keep it alive. This has given rise to several 3rd party gardening services. While these services provide convenience

to the users, it undermines the point of planting - to have a hands-on experience of taking care and nurturing a living object. It can even inhibit the formation of attachment between the customer and the plant. Which can further lead to the customer quickly moving on to an instant, more exciting activity if the plant dies.

1.3. Gamification & GUTHS

Gamification is defined as the use of game elements in non-game systems. It is now established as a relevant research field in human-computer interaction (HCI). Several empirical research studies have gamification can improve user engagement and obtain desired user outcomes. One of the prime examples of engagement based gamification in the current generation is the snap streaks feature on Snapchat. It promotes users to use the app every day and send a snap (a picture) to their friend to maintain the streak. This feature does not account for the effect it has on the user. In fact, very few applications of gamification focus on the desired user outcome. One such example is Volkswagen's Piano Staircase at the Odenplan subway in Stockholm, Sweden [18]. The staircase was made to represent a piano keyboard and it would play a musical note when it was stepped on. AS a result, 66% more people used stairs over the escalator [19].

Gamification tackles several issues in various sectors that report low performance from users. Boredom, lack of engagement and repetition are the reasons for dropouts in the education sector [20]. Similarly, employee training programs are affected by minimal interest and short attention spans [21][22]. In both these areas, the use of gamification is rampant. However, just assigning points, badges and leaderboards to applications do not solve the problems - we need a complete understanding of the game mechanisms and the effects of gamification.

The GUTHS maps user personality onto design elements. GUTHS is a scale based on a self-reported survey that delineates the different user motivations in participants' interaction with gamified applications. Called the Hexad framework, it has 6 different types of user types which are defined to represent a style of interaction used in gamification such as interactions focused on achievements, socialization or rewards. The user types are created based on differences in styles of interactions while playing games. The Hexad User Types framework is useful to determine user types of users who are non-gamers and might not be aware of game terminology or conscious of their gaming preferences. We chose to use the Hexad framework due to the incorporation of a gamified context as opposed to a normal survey based user preferences of game elements.
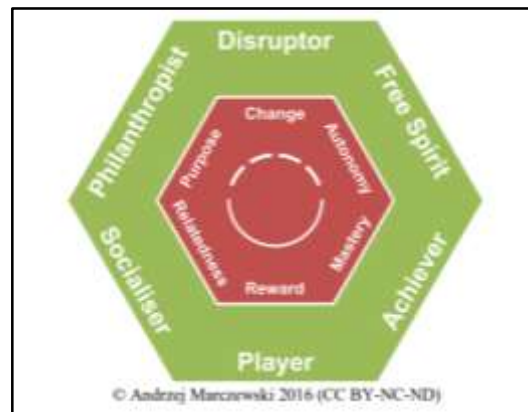
II. Methodology

2.1 The GUTH Scale

Fig 2.1. The GUTHS

As discussed above, the aim of GUTHS is to match gaming elements with certain user profiles defined in [23]. Thus, the scale aims to select appropriate gamification elements based on the characteristics of a target audience and individualize the design of gamification when designing gamification systems. GUTHS has focused on six user types Figure 2.1 — as we explained in Table 2.1 which summarizes the factors and the corresponding scale items and game elements.

Table 2.1. GUTHS User types and item list

User Type	Scale items	Suggested game elements
Philanthropist (4 items)	- Helping others brings me happiness - I like to share my knowledge. - I like helping people to prepare for new situations. -The wellbeing of others is important to me.	- Collection and Trading - Gifting - Knowledge sharing - Administrative roles
Socializer (4 items)	- Interacting with others is important to me. - It is important to me to feel like I am part of a community. - I like being part of a team. - I enjoy group activities.	- Guilds or Teams - Social networks - Social comparison or pressure - Social competition - Social discovery

Free Spirit (4 items)	- It is important to me to follow my own path. - I like to try new things. - I am often curious and allow it to guide me - I like my independence	- Exploratory tasks - Clues - Nonlinear gameplay - Unlockable items - Customization
Achiever (4 items)	- I like defeating obstacles. - I do not give up on a problem unless I have found a solution to it - I always complete my tasks - I like mastering difficult tasks.	- Challenges - Quests - Certificates - Progression or Levels - Learning
Disruptor (4 items)	- I see myself as a rebel. - I often find myself enjoying provocation - I like to question the status quo - I dislike following rules.	- Anonymity - Innovation platforms - Anarchy - Development tools
Player (4 items)	- Rewards are a great way to motivate me. - Return of investment is important to me. - I like competitions where a prize can be won. - I put effort only if the reward is good enough for me	- Leaderboards - Lotteries - Badges - Points - Virtual currency - Prizes or Rewards

2.2 Survey

We conducted an online survey made using Google Forms. The language of the survey was English and contained the following sections:

1. Demographic information: Responses were anonymous and the only personal information they were asked to enter was their age. This was to ensure that our responses lie within the Gen Z age group (between 6 to 22, in the 2019).

2. Hexad User Types survey items: the participants rated the 24 times on the questionnaire to a 7 point Likert scale.

2.3 Participants

93 participants entered their responses in the online survey. Each answered all the 24 questions. From these 93 responses, 1 response was discarded after being identified as redundant, resulting in an effective total of 92 responses. Since the survey was for the Gen Z age group, we reached out to respondents via social networks

(Instagram, Facebook, LinkedIn and Reddit). 4% of the respondents were under the age of 18 and the remaining 96% were between 18 and 22 years of age. Answers were collected in November 2019.

2.4 Scale Reliability

The reliability of the GUTHS was determined by computing the Cronbach's alpha internal consistency coefficient. Table 2 shows Cronbach's alpha internal consistency coefficients of the factors in the original scale. It shows all alpha values greater than 0.71. While there is no rule of thumb for Cronbach's alpha coefficients [24], it can be said that α coefficient is directly proportional to the number of items with shared covariance.

Table 2.4. Scale Reliability

User Type	Cronbach's alpha
Philanthropist	0.89
Socializer	0.83
Free Spirit	0.72
Achiever	0.75
Disruptor	0.73
Player	0.69

2.5 Results

Our survey results were calculated using the Likert Scale and the results are as shown in Table 3 & chart 1.

Table 2.5.1. Test Results

User Type	Test Result
Philanthropist	*18.8401547*
Socializer	16.4556962
Free Spirit	*18.2357947*
Achiever	*17.9391702*
Disruptor	12.2647679

Player	16.2644163

Once factor scores are calculated using the data obtained through GUTHS, the factor with the highest score shows the dominant user type of an individual [25]. The obtained scores were converted into percentages with the following formula to determine each individual's dominant user type [26]:

$$Dominant\ User\ Type\ Score = Score\ of\ the\ Factor\ \div$$
$$The\ Highest\ Possible\ Score\ of\ the\ Factor\ \times\ 100$$

The obtained results in percentages are shown in Table 2.5.1**.** The top 3 user types have been highlighted in italics - Philanthropist, Free Spirit and Achiever. Based on the results, GUTHS and the context of our plant app, we propose following game mechanics as shown in Table 2.5.2.

Table 2.5.2. Proposed Game Elements

User Type	Suggested game elements
Philanthropist (4 items)	- Collection - Meaning - Gifting - Knowledge sharing
Free Spirit (4 items)	- Exploratory tasks - Nonlinear gameplay - Unlockable or rare content - Customization
Achiever (4 items)	- Challenges - Learning - Levels or Progression

III. Discussion

3.1 Dominant User Types

[25] found positive correlations between Philanthropist - Socialiser, Free Spirit - Disruptor, and Achiever - Player. As a result of this correlated, we decided to select 3 dominant user types from the results.

3.1.1 Philanthropist

Philanthropists are altruistic, willing and agreeable. They look for meaningful and purposeful game systems. These users give without expecting a reward. As long as their action involves a purpose. This user type feels that they are part of something greater and are willing to contribute to it, because they enjoy helping. They enjoy games that enrich others and fulfil their sense of purpose. The context of planting and gardening is naturally altruistic, which explains why the high percentage of users belong to this user type. The game mechanics prefered by Philanthropists are collection and trading, gifting, knowledge sharing, and administrative roles [25]. Our solution therefore, as seen in Fig 2, proposes the use of learning cards and reviewing cards. For each learning card, two reviewing cards are issued with the allowance of one attempt in case the user gets the answer wrong. This is to ensure maximum memory retention. This section of our solution constitutes the first part of level 1, in which we want to emulate the theoretical aspects of learning in educational systems.
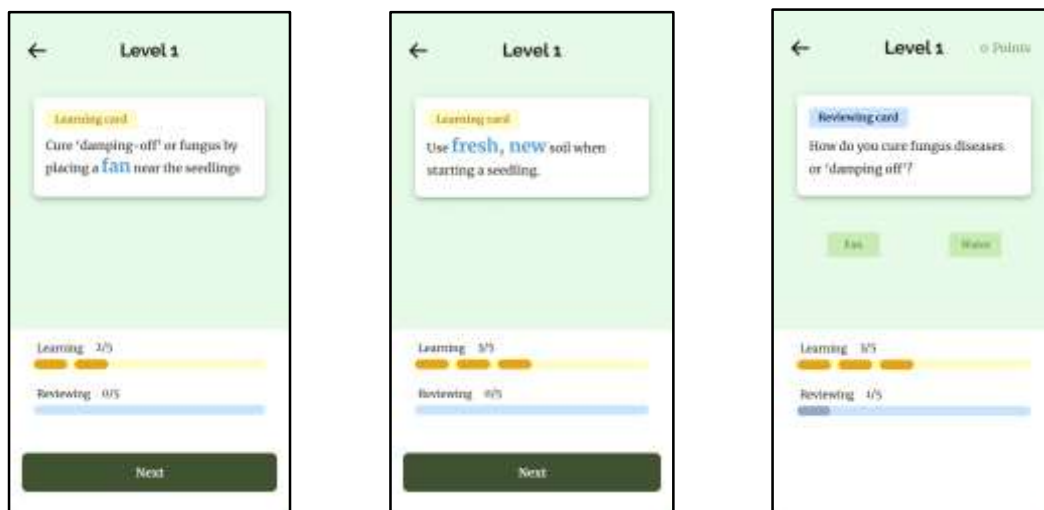

Figure 2. Level 1 (Planting) showing the Philanthropist game elements

3.1.2 Free Spirit

Players of this user type are motivated by creativity tools and autonomy. They prefer having the freedom to play without having external control. They have a positive correlation to openness to experience and thus prefer systems that enable them to be creative or explore the game space. They are similar to the Disruptor user type but differ on the basis of not being neurotic. The game mechanics prefered by Free Spirit are nonlinear gameplay,

creativity tools, Easter eggs, exploratory tasks, unlockable content, and customization [25]. In our proposed solution, we use the exploratory task game mechanic to let the user go through a 'Experiential Learning' Level (which constitutes the second half of Level 1). As shown in Figure 3, our solution involves the same learning elements the user learnt in the first part but this time in an experiential method by using visual graphic elements and GIF animations. Similarly, Level 2 (Nurturing) follows an experiential visual user experience to play music for plant growth and water to ensure plant health. The levels follow a linear scale as shown in the bottom of the figure.
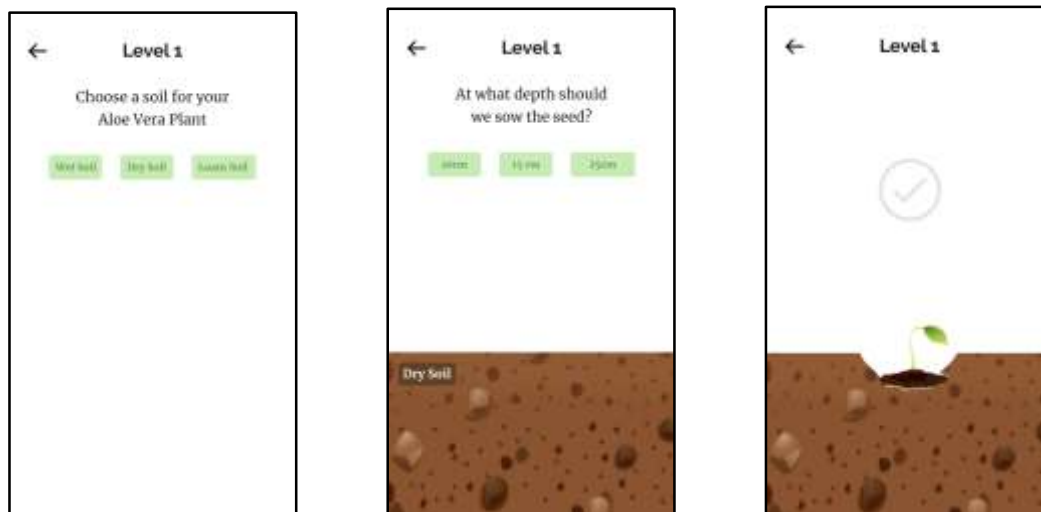

Figure 3. Level 1 (Planting) showing the experiential learning section
as a part of the Free Spirit game mechanics

3.1.3 Achiever

Achiever comes from the four user types of the Bartle's Player Model which includes Achiever, Socialiser, Explorer and Killer. Achievers are motivated by competence and they are driven by a quest for mastery. This user type uses tasks as checkpoints to progress through levels. They enjoy challenges more than other user types. The game mechanics prefered by Philanthropists are challenges, certificates, learning new skills, quests, levels or progression, and epic challenges [25]. Figure 5 shows the achiever game elements incorporated in our solution such as points, levels, rewards and goals. While the app's aim is to supplement the learning process of planting by using a virtual plant, we also wanted to ensure that there is a real life incentive associated with completing these levels. Which is why we propose to involve a subsidized or free plant seed packet as a reward at the end of completion of the challenges.
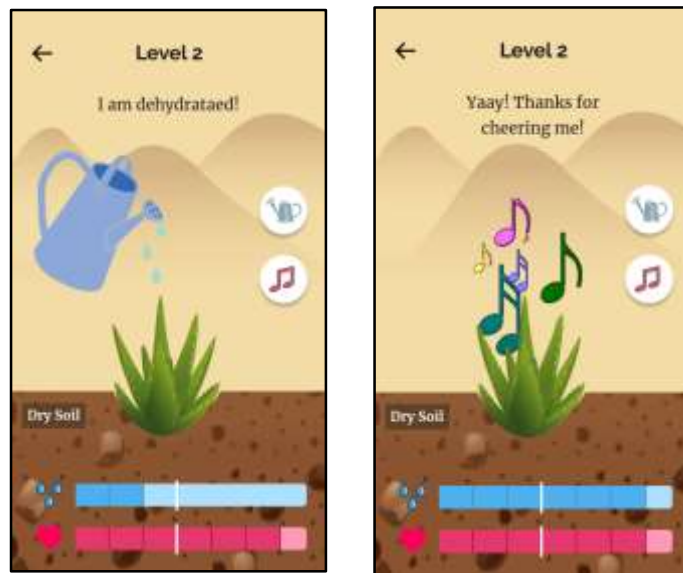
Figure 4. Level 2 (Nurturing) showing the experiential learning section

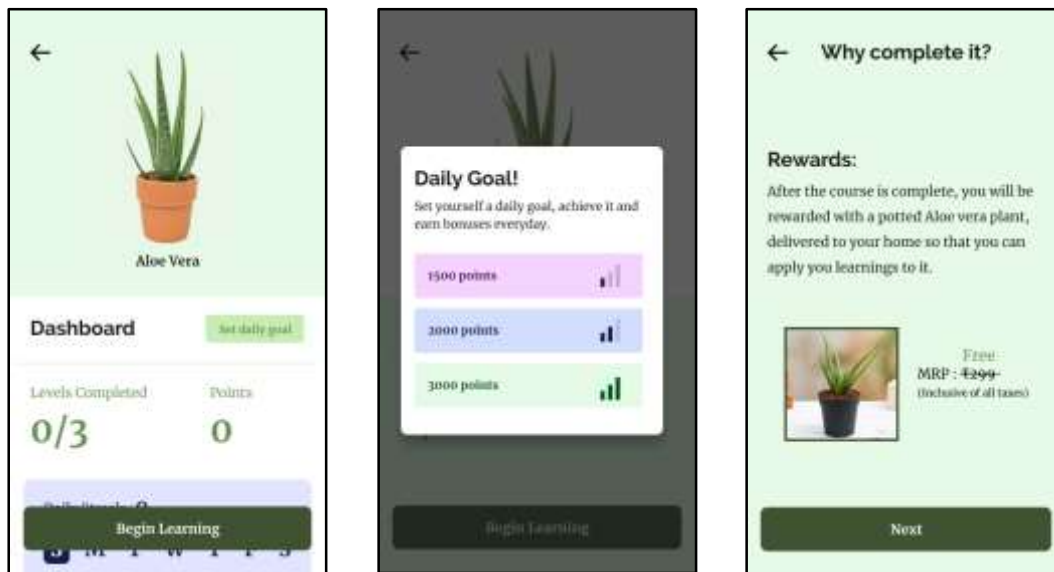*as a part of the Free Spirit game mechanics*

Figure 5. App intro showing the levels, points, goals and rewards section

as a part of the Achiever game mechanics

IV.   Limitation

GUTHS which is based on [23] User Type Hexad framework and is validated by [25] is promising but relatively new in Gamification research, so it is hard to find extensive research done on the relation between gamification and user types. Further, to incorporate the context of plants in our survey, we used storyboards [27]. We use a self-reported survey to collect data which implies that the responses are subject to the correspondent's understanding of the storyboards and of the items in the survey. In [28] proven that users can relate between storyboard and game mechanics. Our survey respondents were 96% between the ages of 18 to 22. Only 4% were below 18. A more accurate description of the Gen Z age group should involve the younger ages of 6 to 18 too. It is highly likely that gamifying the relationship between plants and humans would involve a digital solution, which we do not wish to promote in the younger Gen Z age group and hence we focused on the latter half of the age group. Moreover, [25] concluded that Philanthropist user type has not been studied completely in terms of their user preferences in games. However, since the entire application domain of nurturing plants falls under the Philanthropist characterization, we overlooked this limitation.

V.   Conclusion

We extended research done in gamification in HCI and in technology for plant education by using the GUTHS to determine the dominant user types in our chosen target audience - Gen Z for the planting context. We also study the positive effects of plants throughout the generations and the decline but strong relevance of plants in the lives of Gen Z. Further, we determine the game mechanics based on the dominant user types and have created a general algorithm to design incentive based, gamified experiences for promoting plant education and habits. Our work is also an extension of previous work done in creating gardening kits for children which did not involve gamification and reported boredom as a drawback of the simplicity. Gamification using the Achiever user type implements reward systems which build momentum for fun while establishing the habit of planting. Moreover, to help Gen Z users overcome the negative emotion of a plant dying, our concept of a virtual planting app promotes learning without that fear. By having levels of easy, medium and difficult plants that children can virtually grow, we ease them into a natural progression of levels while keeping them interested.

References

[1]   Passy, R., Morris, M., Reed, F., Royal Horticultural Society (Great Britain), & National Foundation for Educational Research in England and Wales. (2010). *Impact of School Gardening on Learning: Final Report Submitted to the Royal Horticultural Society*.

[2]   *Introduction and Importance of Medicinal Plants and Herbs | National Health Portal of India*. (n.d.). Retrieved March 30, 2020, from http://nhp.gov.in/introduction-and-importance-of-medicinal-plants-and-herbs_mtl

[3]   Orwell, R. L., Wood, R. L., Tarran, J., Torpy, F., & Burchett, M. D. (2004). Removal of Benzene by the Indoor Plant/Substrate Microcosm and Implications for Air Quality. In *Water, Air, & Soil Pollution* (Vol. 157, Issues 1-4, pp. 193–207). https://doi.org/10.1023/b:wate.0000038896.55713.5b

[4] Dijkstra, K., Pieterse, M. E., & Pruyn, A. (2008). Stress-reducing effects of indoor plants in the built healthcare environment: the mediating role of perceived attractiveness. *Preventive Medicine*, *47*(3), 279–283.

[5] Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science*, *224*(4647), 420–421.

[6] Lohr, V. I., & Pearson-Mims, C. H. (2005). Children's Active and Passive Interactions with Plants Influence Their Attitudes and Actions toward Trees and Gardening as Adults. In *HortTechnology* (Vol. 15, Issue 3, pp. 472–476). https://doi.org/10.21273/horttech.15.3.0472

[7] Tennessen, C. M., & Cimprich, B. (1995). Views to nature: Effects on attention. In *Journal of Environmental Psychology* (Vol. 15, Issue 1, pp. 77–85). https://doi.org/10.1016/0272-4944(95)90016-0

[8] Han, K.-T. (2009). Influence of Limitedly Visible Leafy Indoor Plants on the Psychology, Behavior, and Health of Students at a Junior High School in Taiwan. In *Environment and Behavior* (Vol. 41, Issue 5, pp. 658–692). https://doi.org/10.1177/0013916508314476

[9] Smith, A., Tucker, M., & Pitt, M. (2011). Healthy, productive workplaces: towards a case for interior plantscaping. In *Facilities* (Vol. 29, Issue 5/6, pp. 209–223). https://doi.org/10.1108/02632771111120529

[10] Han, Ke-Tsung & Hung, C.-Y. (2011). Influences of plants and their visibility, distance, and surrogate in a classroom on students' psycho-physiology. *Journal of Architecture and Planning.* 12. 1-22.

[11] Ferguson, Kim & Cassells, Rochelle & Macallister, Jack & Evans, Gary. (2013). The physical environment and child development: An international review. *International journal of psychology : Journal international de psychologie.* 48. 10.1080/00207594.2013.804190.

[12] World Health Organization. (2017). Don't pollute my future! The impact of the environment on children's health. World Health Organization. https://apps.who.int/iris/handle/10665/254678

[13] Shoemaker, C. A. (1990). PLANTS AND HUMAN CULTURE. In *HortScience* (Vol. 25, Issue 9, p. 1174G – 1174). https://doi.org/10.21273/hortsci.25.9.1174

[14] Lohr, V. I., & Pearson-Mims, C. H. (2005). Children's Active and Passive Interactions with Plants Influence Their Attitudes and Actions toward Trees and Gardening as Adults. In *HortTechnology* (Vol. 15, Issue 3, pp. 472–476). https://doi.org/10.21273/horttech.15.3.0472

[15] *Why do millennials love houseplants?* (2020, January 22). https://www.floraldaily.com/article/9182512/why-do-millennials-love-houseplants/

[16] Bond, C. (2019, September 18). *Why Millennials Are Suddenly So Obsessed With Houseplants*. HuffPost; HuffPost. https://www.huffpost.com/entry/millennials-obsessed-houseplants-instagram_l_5d7a976de4b01c1970c433b9

[17] *Growing Plants and Relationships - Greenhouse Product News*. (n.d.). Greenhouse Product News. Retrieved March 30, 2020, from https://gpnmag.com/article/growing-plants-and-relationships/

[18] Diaz, A.-C. (2009, October 7). *Behind the Work: Volkswagen's "The Fun Theory."*

https://adage.com/article/behind-the-work/work-volkswagen-s-fun-theory/139512

[19] Bates, B. C. (n.d.). *Scaling new heights: Piano stairway encourages commuters to ditch the escalators*. Mail Online; Daily Mail. Retrieved March 30, 2020, from https://www.dailymail.co.uk/sciencetech/article-1218944/Scaling-new-heights-Piano-stairway-encourages-commuters-ditch-escalators.html

[20] *Website*. (n.d.-a). Retrieved March 30, 2020, from http://www.nytimes.com/2010/11/21/technology/21brain.html?pagewanted=all&_r=2&

[21] *Website*. (n.d.-b). Retrieved March 30, 2020, from http://www.dummies.com/how-to/content/evaluating-the- Effectiveness-of-an-employeetrainin.html

[22] *Website*. (n.d.-c). Retrieved March 30, 2020, from http://trainingstation.walkme.com/how-to-measure-employee-training-effectiveness/

[23] Marczewski, A. C. (2015). *Even Ninja Monkeys Like to Play: Gamification, Game Thinking and Motivational Design*. Createspace Independent Publishing Platform.

[24] Cho, Eunseong & Kim, Seonghoon. (2015). Cronbach's Coefficient Alpha: Well Known but Poorly Understood. Organizational Research Methods. 18. 207-230. 10.1177/1094428114555994.

[25] Tondello, G. F., Wehbe, R. R., Diamond, L., Busch, M., Marczewski, A., & Nacke, L. E. (2016). The Gamification User Types Hexad Scale. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play - CHI PLAY '16*. https://doi.org/10.1145/2967934.2968082

[26] Akgün, Ö. E., & Topal, M. (2018). The Turkish Adaptation Study of the Gamification User Types Hexad Scale. In *International Journal of Assessment Tools in Education* (Vol. 5, Issue 3, pp. 389–402). https://doi.org/10.21449/ijate.379139

[27] Orji, R., Tondello, G. F., & Nacke, L. E. (2018). Personalizing Persuasive Strategies in Gameful Systems to Gamification User Types. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18*. https://doi.org/10.1145/3173574.3174009

[28] Orji, R., Mandryk, R. L., & Vassileva, J. (2017). Improving the Efficacy of Games for Change Using Personalization Models. In *ACM Transactions on Computer-Human Interaction* (Vol. 24, Issue 5, pp. 1–22). https://doi.org/10.1145/3119929