

# **Refresher Training through Gamified Activities for Frontline Healthcare Workers on Maternal and Newborn care**

Submitted in partial fulfillment of the requirements  
of the degree of

Doctor of Philosophy

by

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Dedicated to my beloved parents.



## **Thesis Approval**

This thesis entitled **Refresher Training through Gamified Activities for Front-line Healthcare Workers on Maternal and Newborn care** by **Arka Majhi** is approved for the degree of **Doctor of Philosophy**.

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## **Declaration**

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## CERTIFICATE OF COURSE WORK

This is to certify that **Arka Majhi** (Roll No. 184350001) was admitted to the candidacy of Ph.D. degree on 12 July 2019, after successfully completing all the courses required for the Ph.D. programme. The details of the course work done are given below.

S.No	Course Code	Course Name	Credits
1	TD 606	Public Policy and Governance in Technology and Development	6
2	TD 621	Food Processing and Nutrition Delivery	6
3	DE 668	Instructional Design	4
4	TD 694	Seminar	4
5	TD 610	Contemporary Critical Issues in Technology and Development	0
6	HS 791	Communication Skills -I	PP
7	TD 792	Communication Skills -II	PP
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# **Abstract**

High and persistent levels of child malnutrition continue to be a matter of concern in India. The universal coverage of children under different healthcare and nutritional programmes has witnessed a rapid increase in the number of Frontline Workers (FLWs) or Community Healthcare Workers (CHWs) i.e. the Anganwadi Workers (AWWs) and the Accredited Social Health Activists (ASHAs). The job training and the refresher training of these workers leave a lot to be desired. The capacity deficit of field functionaries has been identified as a major factor affecting the effectiveness of this programme. Given the massive numbers of field functionaries and the continuously advancing base of knowledge and techniques, conventional training pedagogy is ineffective in building and updating the capacity of the Frontline Healthcare Workers and their supervisors. With the improvement of technology and widespread availability of smartphones in cities as well as rural and tribal villages of India, access to digital training systems can potentially benefit the healthcare workers and the healthcare system to a large extent, rendering reduced malnutrition and infant mortality rate, countrywide. The conventional training methods are proving to be inadequate for the task. Gamification of the training material for the refresher training and use of digital tools for its dissemination offers one potential solution to this problem which is the subject matter of the doctoral research. The care protocol is gamified through different gaming options, and digital versions of these games are developed which are playable on the android platform. Card games appear as highly suitable for this purpose, and their customization for the training content is in progress. The study compares the effectiveness of the game-based learning pedagogy and conventional classroom instruction with a group of ASHAs, and discusses ways to make it an adequate refresher training substitute.



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# List of Abbreviations

<b>ASHA</b>	Accredited Social Health Activist
<b>AWW</b>	Anganwadi Worker
<b>AWH</b>	Anganwadi Helper
<b>AWC</b>	Anganwadi Centre
<b>CHW</b>	Community Health Worker
<b>NFHS</b>	National Family Health Survey
<b>CNNS</b>	Comprehensive National Nutrition Survey
<b>ICDS</b>	Integrated Child Development Services
<b>IFA</b>	Iron and Folic Acid
<b>MWCD</b>	Ministry of Women and Child Development
<b>LMIC</b>	Low and Middle income Countries
<b>LISA</b>	Local Indicators of Spatial Association
<b>PHC</b>	Primary Healthcare Centre
<b>mHealth</b>	Mobile Health
<b>FDG</b>	Focused Group Discussion
<b>MCPC</b>	Mother and Child Protection Card
<b>IAP</b>	Indian Academics of Paediatrician
<b>ORS</b>	Oral Rehydration Solution
<b>ANC</b>	Antenatal Care
<b>GLO</b>	General Learning Objectives
<b>SLO</b>	Specific Learning Objectives

**MCQ**      Multiple Choice Question

**CINI**      Child in Need Institute

# **Chapter 1**

## **Introduction**

### **1.1 Background**

**H**ealthcare systems worldwide are struggling with a shortage of Community Health Workers (CHWs) or trained health workers, especially in low-and-middle-income countries (LMICs), reaching an estimated deficit of 80 million by 2030 (Organization, 2016). It remains a challenge for LMICs to train or educate CHWs ensuring the most vulnerable population's good health and well-being (Organization, 2016). National Family Health Survey 5 (NFHS-5) has shown a decline in levels of child malnutrition in India for children under 5 years age. Stunting reduced from 38.4% (NFHS-4 2015-16) to 35.5% (NFHS-5 2019-21). Wasting, which stood at 21% (NFHS-4), has reduced to 19.3% (NFHS-5). The levels of underweight reduced from 35.8% (NFHS-4) to 32.1% (NFHS-5). High and persistent child malnutrition levels with tardy reduction, seen in successive health surveys, continue to be a matter of concern in India. It draws attention to the need to revamp the more than 45-year-old flagship program of the Government of India, the Integrated Child Development Services (ICDS), under the Ministry of Women and Child Development (MWCD), focusing on children (below 6 years), pregnant women, and lac-

tating mothers. Studies strongly flag the need for improved knowledge and awareness among AWWs and ASHAs, whose knowledge and skills impact the program's implementation.

ASHAs are state-government-employed CHWs tasked with delivering last-mile care for their own community. They are not salaried but incentivized for their work which is considered voluntary in nature. The role of ASHAs is to act as an intermediary between their own community and the government healthcare infrastructure. ASHAs' activities include data collection, healthcare provision, and information dissemination in her own community. Special attention is paid to the health of mother and child.

CHW's education level and nutrition knowledge plays an essential role in her regular duties (Gujral et al., 1991). The authors also commented that most of the CHWs were unclear about the basics of their daily work. The unskilled population among AWWs was considered as the leading cause for keeping growth charts unfilled. The rate of success of ICDS largely depends on the way the AWWs are prepared to tackle the problem of malnutrition, which thus becomes a concern, to train and upgrade AWWs with quality training with enhanced and advanced nutrition knowledge as it determines the performance of AWWs (Gujral et al., 1991). Training and supervision were identified as one of the most ignored intervention-related aspects in systematic reviews of CHW success factors (Kok et al., 2015). Research on training and education of Community Healthcare workers is scarce. Few academic researchers have attempted to train and educate Community Healthcare workers using technology solutions like ICT, community radio and multimedia as a medium through feature phones and smartphones (Yadav et al., 2017, 2019a,b). This research builds on and contributes to the previous research studies conducted by Indian researchers on making games and gamified systems (Majhi et al., 2021; Tulaskar, 2020) for training Community Healthcare Workers.

## 1.2 Motivation

- Traditionally the field workers are trained in a physical classroom environment following the cascading model of teaching the Master Trainer of state and districts and then the field functionaries. In these massive teaching classes, it is often difficult to pay attention to the learners or the field functionaries individually. The trainers and learners also complain

about inadequate infrastructure for conducting training and assessing the knowledge gains in crowded classrooms.

- The rise in smartphone ownership among healthcare workers in India opens up an opportunity to utilize mHealth approaches to bridge the gap of healthcare access and engagement with the beneficiaries of the target population.

### **1.3 Research objectives**

In this doctoral research, the study focuses on understanding if a content gamification approach in refresher training can help educate frontline healthcare workers in India. We would also compare the benefits which the gamified activity provides compared to other strategies and discuss the challenges faced while designing it for community healthcare training. In this research, we would also attempt to answer the following questions.

1. Can a gamified activity approach effectively train healthcare workers in India?
2. Are there benefits of gamified activity approach when compared to other approaches of training in community healthcare?
3. What are the different challenges and considerations to consider while designing gamified activities from scratch intended to train community healthcare workers?

### **1.4 Method**

The process of designing gamified activities and evaluation would be broadly carried out in 6 stages following an iterative design thinking process.

- Definition of the set of objectives
- Literature Review of previous research
- Design of the game (participatory design)

- Designing the challenges
- Drafting rules of playing the game
- Validation of the educational material
- Evaluation of the physical activity through field testing or play testing
  - \* Tests for knowledge retention and their application in real life (Kirkpatrick's lower and higher levels)
- Making a digital version of the gamified activity for smartphones and tablets
- Evaluation of the digital gamified activity through field testing (conducting similar tests as performed for the physical activity)
- Iterative redesigning and reevaluating as required
- Compare the results of the physical and the digital gamified activity

# **Chapter 2**

## **Review of Literature**

### **2.1 Access to mobile phones and internet services**

According to a press release (Telecom Regulatory Authority of India, 2021), out of the 1173.83 million telephone subscribers as on December 31, 2020 in India, 44.8% (525.92 million) were rural telephone subscribers. Out of them, 99.66% (524.11 million) were rural wireless telephone subscribers making 45.43% share of the total wireless subscribers. Based on NSS 75th Round (July 2017-June 2018) (MoSPI, 2015), it was found that 15% of rural households in India have access to the internet. Finance Minister of India Nirmala Sitharaman, while presenting the Union Budget 2020-21 announced that over 0.6 million AWWs in India were smartphone equipped in 2020 for uploading the nutritional status of more than 100 million households. The rise in smartphone ownership among healthcare workers in India opens up an opportunity to utilize mHealth approaches to bridge the gap between healthcare access and engagement with the beneficiaries of the target population (Ganapathy and Ravindra, 2008; Bassi et al., 2018; Madanian et al., 2019).

## **2.2 Introductin to mHealth**

Mobile Health or mHealth is defined as "medical and public health practice supported by mobile devices" (WHO, 2011), thus having the potential to overcome the limitations of the traditional methods of receiving child and maternal healthcare through job cards or printed paper brochures. mHealth is a means to disseminate healthcare information cost-effectively and personalized to socioeconomic and cultural needs to fit the context.

Researchers from developing countries have provided suggestions for designing effective mHealth interventions (Kumar and Anderson, 2015). These include communicating with the community through radio and text messages (both automatic and human-aided). Studies have been conducted to motivate health workers and increase their knowledge by deploying short videos on mobile phones (Ramachandran et al., 2010). Another study (Kumar and Anderson, 2015) from India found that watching short films on mother and child care empowered Health Workers and mothers to manage pregnancies proactively. Shah. et al. (Shah et al., 2017) from India did a similar study on an incentive-based approach for training AWWs through mobile-based videos. The AWWs' feature phones were loaded with videos related to mother and child healthcare. A few questions with their correct answers related to the content of the video were appended to the video. After watching these videos, AWWs were supposed to call on a toll-free number, where they would be quizzed on the same questions as shown in a particular topic video. AWWs were awarded cellular talk time as an incentive for answering correctly. Another study (Pérez et al., 2020) from India, found that 'Tika Vaani', an IVR-based mHealth solution to improve knowledge on immunization has shown significant results in improving healthcare knowledge if the content is customized to meet the needs of less-literate users.

## **2.3 mHealth interventions through e-Learning, Serious Games and Gamification**

e-Learning is a teaching and learning approach, through an educational model focusing on improving access to training, communication, and interaction by adopting electronic media

and devices for promoting novel understanding and enhancing learning (Sangrà et al., 2012). 'Blended Learning' happens when e-Learning and face-to-face teaching are combined. 'Educational game' pedagogy requires learners' participation while performing competitive activities following previously set game rules. A Cochrane review (Akl et al., 2010) studied two physical games for educating healthcare professionals and confirmed games as an effective strategy for teaching. The application of games focusing on 'serious intent' has been observed in various domains like health, training, defense, education, military, aviation, city planning, politics, and ecology with multiple approaches (Alvarez 2012). Researchers have been using similar terms like Game-Based-Learning, Games-for-Good, Alternative-Purpose-Games, (Sawyer and Smith, 2008), and Edugaming (Angarita et al., 2005) while describing similar interventions.

Clark Abt first outlined the idea of 'Serious Games' in his book, published in 1970 named 'Serious Games'. He described 'Serious Games' as the games that "have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement" (Abt, 1970). Serious Games combines learning theory and empirical outcomes for improving skill learning along with the principles of game design. Interventions through serious game design can enhance cognitive, social, and health-related skills beyond the context of the game (Ritterfeld et al., 2009; Giunti et al., 2015). The number of articles and systematic reviews on serious games in healthcare education is growing (Graafland et al., 2014; de Ribaupierre et al., 2014; Laamarti et al., 2014; De Wit-Zuurendonk and Oei, 2011).

For this doctoral research, the definition by Alvarez 2015 and 2012 would be considered. The games created with the serious purpose of providing healthcare education delivered through digital devices are Serious Games. Serious Games provide a gaming experience through rules, engines, and mechanics. But gamification tries to create a similar experience through applying game mechanics and involving fun while performing mundane activities with developing motivational and cognitive abilities. Sebastian Deterding defined gamification as the "use of game design elements in non-game contexts" (Deterding et al., 2011b,a; Deterding, 2011, 2012). Gamification potentially allows higher involvement of the player in setting up the objectives and outcomes, thus personalizing the intervention and make it cost-effective (Wortley). The increase in inequality of access to resources for healthcare, lack of adherence to treatment (Vicente et al., 2014), and increased healthcare cost (Lenihan, 2012) generated the need for applying gamification in digital healthcare services. Self-Determination Theory suggests use of intrinsic and

extrinsic motivations in the context of game design (Ryan and Deci, 2000). Extrinsic motivators are game elements such as badges, points, progressbar and leaderboards (Ryan and Deci, 2000). While extrinsic motivators are the feelings of 'mastery' or feeling of accomplishment towards the goal, 'autonomy' or the freedom of sense of play, and 'relatedness' or connecting players to goal and passion (Deterding et al., 2011b).

## 2.4 Educational Theories and Serious Gaming

Malcolm, in his book (Knowles, 1980), stresses the factors which support adult learning. Serious Games and Gamification techniques can also help in achieving those.

- With every experience faced, there is a tendency to move from dependency to autonomy. Games facilitate this by providing an active learning environment through independence in moves or choices made in games.
- Past learning is used in dealing with our current problems. Games challenge us to deal with different situations as per our prior knowledge.
- With age, people tend to be more focused on the task goal. Games train us to be goal-oriented by targeting small tasks and completing levels.
- With age people tends to learn from tasks, based on practical problems and less on educational content. Games facilitate learning through design problems, which are inspired by practical problems.

Learning through games supports the 'cognitive theory of multimedia learning' (Mayer, 1997), which says that learning happens better when both visual and auditory senses are involved. Another theory (Siemens, 2005) proposes that learning is not a linear process, but meandering through changing environment. Serious Games also follow similar mechanisms. Researchers (Mey, 2005; Gee, 2012) showed that games are compelling as learning happens within meaningful contexts. Any training method can be evaluated for effectiveness and validated through Kirkpatrick's 4 levels of outcome (McFarlane, 2006), training reaction (1<sup>st</sup> Level), improvement in learning (2<sup>nd</sup> Level), improvement in behaviour (3<sup>rd</sup> Level) and training outcome or results (4<sup>th</sup> Level). Training through Serious Games has resulted in longer engagement

in training and improvements in learning gains. Experiential Learning Theory (Kolb, 1984) suggests that after gaining knowledge, every learner observes, reflects, and analyzes it, creating abstract concepts in mind and actively experimenting with them by applying their learnings to see the results. Serious Games can target every stage of this process and support the creation of knowledge through the experience of game play. For combining learning and gaming, Ritterfeld suggests three ways (Ritterfeld and Weber, 2006).

- Reinforcement model: Learning rewarded with entertainment
- Motivation model: Entertainment encourages learner's interest and attention
- Blended model: Process and result of learning itself becomes exciting

Out of them the blended approach seems to be most effective because it provides intrinsic satisfaction of learning (Breuer and Bente, 2010), and provide fun while learning (Koster, 2010).

To achieve predefined learning objectives in mind, a Serious Game in its design phase needs to follow a grounded design approach (Hannafin et al., 1997) and align with educational theories. Choosing behaviorism or constructivism as an approach while designing the game can influence the learning theories and instructional strategies of the playful activity (Gunter et al., 2008). The learning approach defines the characteristics of the training environment. It also controls the pace and frequency of interactions intended for critical learning through the Serious Game targeted toward the learning outcomes of the learner.

In this research, the constructivist theory of learning for designing was chosen. The health-care workers would need to understand information and extract meaning from the game's content. Then, they will construct knowledge by applying the learning to overcome the game's situations which would ideally cascade later in their daily practices. For the construction of knowledge, Bloom proposes six levels of understanding of a subject ranging from simple to challenging levels (Krathwohl et al., 1969). Bloom's taxonomy acts like a palette for choosing suitable learning approaches corresponding to the knowledge level expected from the learner.

Gagné's nine-step framework (Gagné et al., 2010) for creating learning environments ensures that the learner will master the content, reach the learning objectives and ascend through Bloom's six levels of learning. Scenarios of Serious Games are created by keeping in mind Bloom's taxonomy and Gagné's instructional events, providing a methodological guide for

developing strategies for learning. The activities of the storyline should be intended toward learning objectives of each level throughout the scenario.

## 2.5 Current status of child immunization

Through immunization, 2-3 million lives are saved each year from diseases that vaccines could prevent (Andre et al., 2008). Across the world, about 19.4 million children, with age less than 12 months, missed the necessary vaccination, with 11.7 million from LMIC countries and 2.6 million of them being Indian (World Health Organization, 2016). A study on NFHS-4 data found that the immunization cover of children in 163 districts in India was less than half (Panda et al., 2020). 47% of children belonging to the lowest wealth quantile households in India, are not fully immunized, and any health insurance does not cover 71% of families (Indian Institute Population Sciences and Ministry of Health and Family Welfare, 2016). As a result, they end up spending significant amounts on healthcare, pushing almost 32-39 million people annually to dip below the poverty line (van Doorslaer et al., 2006; Garg and Karan, 2009).

A study (Panda et al., 2020) performed LISA and spatial regression model on NFHS-4 data. Through this study, it was found that mothers receiving ante and post-natal care had better chances of having their children fully immunized. It also found a strong association of full immunization of children with women empowerment indicators like mothers' literacy and women being the authority of the family. However, in spite of vaccination camps being conducted free of cost in Government Hospitals and all rural or urban Primary Healthcare Centres (PHCs) in India still, a significant number of children are still not vaccinated. The study also found that it is mostly ignorance and unawareness among family members regarding vaccination that increases the likelihood of undernutrition in children and results in child mortality and morbidity. The study also suggests the necessity of sensitizing the population, which would improve access to community healthcare. Pockets of the population with poor healthcare access require more targeted steps to bridge the immunization gap. mHealth technologies could help in improving health outcomes and decrease health inequalities (Peek, 2017).

## **2.6 Knowledge Gap of healthcare workers and mothers**

Another focused group discussion was conducted with mothers in a rural village in South 24-Paraganas district in West Bengal and found that, due to the knowledge gap of healthcare workers, the mothers and children in the community are usually left unaware of the medical care, healthcare delivery, checkup services, family planning, etc. Studies conducted in other parts of India also show similar results. A study (Mani et al., 2020) found mothers' low awareness of tetanus, immunization, iron, and folic acid (IFA) tablets. More than half of the pregnant women were unaware of availing pregnancy care services at ANC visits like blood pressure and weight measurement and abdomen examination. Knowledge regarding high-risk conditions in pregnancy and danger signs in pregnancy was also low. Few mothers knew about the various components of institutional delivery and maternity benefit schemes. Though the knowledge regarding spacing of births and contraception in the post-natal period was better, the postpartum intrauterine contraceptive device was non-existent. The designed game would try to bridge the knowledge gap of the community healthcare workers in the above-mentioned topics.



# **Chapter 3**

## **Designing the Refresher Training Activity**

### **3.1 Content for designing Refresher Training Activity**

Conducting a Focused Group Discussion (FGD) among a group of AWWs and ASHAs, it was found that most CHWs lacked complete knowledge of the immunization schedule, growth monitoring chart, and other aspects of the Mother and Child Protection card (MCP card). The findings of other researchers from different parts of India were also similar to our (Bag and Datta, 2017). A study found that the issuing of MCP cards to pregnant mothers was strongly associated with partial immunization in children (Kizhatil et al., 2019). The child immunization table from the MCP card was chosen as content for the game. This schedule also follows the Indian Academics of Paediatrician (IAP) guidelines (Kasi et al., 2021). A reference to the immunization schedule is in Table A.1 in the Appendix.

## 3.2 General and Specific Learning Objectives

Trainers usually or subconsciously have in mind the knowledge, skills, and attitudes they want their learners to achieve through the training course. Learning Objectives are the specifications of the sought outcomes of the training. They break the content into smaller modules with measurable or observable specific desired outcomes. The General Learning Objectives (GLOs) and the Specific Learning Objectives (SLOs) were brainstormed in a closed group and decided on. It was found that the contents mostly correspond to the cognitive domain (new knowledge creation) of learning objectives. Hence affective (developing feelings and emotions) and psychomotor (improving physical and manual abilities) domains are not relevant here. But, supportive layering of learning objectives could strive students to step into these domains.

The GLOs of the game are as follows:

**Audience :** Community Healthcare Workers

- The learner remembers the factual information like immunization schedule and medical supplementation for mother and child
- The learner becomes more aware of the consequences of their actions

The SLOs of the game are as follows:

**Condition :** They should be able to make the right decision in the gameplay scenario.

**Degree :** Depending on the number of right decisions taken (the more, the better)

**Behavior :**

- Memorize the sequence and dosage of immunizations and supplements required by a child from birth to adolescence.
- Memorize the sequence of medicines, immunizations, and checkups required for a pregnant mother.

### **3.3 Physical Card Play as a Learning Tool**

Initial thoughts of game design were that the information about vaccines is displayed to players through blocks of information. Then the player has to make a decision based on the information and the current scenario. Out of many physical tokens and objects of play, card gameplay was chosen as the game artifact. The possibilities of playing through card games were explored. Physical card games are ubiquitous. The primary reasons for this are its cost-effectiveness and handling ease. A deck of cards can be played in numerous different ways just by altering the rules. Different groups of cards can be added to the existing deck to enable new ways of playing with it. Multiplayer card game researchers (Bochennek et al., 2007) have shown significant learning advantages through engagement and collaboration. However, published research papers on using card games for training community healthcare workers were sparse.

The core learning objective of the game is that the community health workers memorize the sequence and dosage of immunizations and supplements required by the child and mother. Initially, there were thoughts of modding the classic physical card games like Rummy, Solitaire, Bridge, Teen Patti, etc. It was easier to think along the lines of combining the rules and mechanics of a popular card game with educational content. However, in several instances of design iterations, the associated traditional rules of play restricted the fulfillment of our learning objectives. As a result, cherry-picking rules and mechanics were performed from several popular card games, which would address and fulfill the learning objectives of the ASHAs.

### **3.4 Designing the cards**

The content can be categorized into 4 silos depending on the time of delivering the care to the stakeholders. 4 silos of cards were made each symbolizing an immunization, medicine supplement or a care activity or event. They are categorized as follows: Children below 1yr (n=22), Children above 1yr (n=15), ANC (n=14) and PNC (n=9) combined to form a deck of 60 cards. The deck of card design is displayed through Figures : G.1, G.2, G.3, G.4 and G.5 in the Appendix section.

These playing cards are made the size of a standard playing card or credit card (5.5 X 8.5 cm), made of card paper (200 GSM), and have printed information and graphics on them.

### 3.5 Combination of cards

These 60 playing cards can be equally divided between 2, 3, 4, 5, or 6 players creating multi-player team combinations. The most common of them is a 4-player match. Theoretically, all the 60 cards could be arranged in a total of  $60!$  ways. But for each of those arrangements, there are many duplicate arrangements in which cards 1 to 15 are the same but in a different order. Similarly for cards 16 to 30, and so on. For each group of 15, there are  $15!$  ways to rearrange them and not change the cards in each player's hands. That's why four factors of  $15!$  would be in the denominator considering a 4-player round. The mathematical expression of the number of permutations possible for each player's hand considering 4 player round is as follows:  $60! / (15! \times 15! \times 15! \times 15!)$  or simplified  $\frac{60!}{(15!)^4}$ . Google Sheet Expression =FACT(60)/POWER(FACT(15),4) which calculates to an astronomical value of 2,845,616,726,065,970,000,000,000,000,000,000

### 3.6 Framing Challenges and Rules

- Before starting the game, the players need to get the deck of 60 cards, shuffle it well, and distribute it equally to 4 players, 15 cards each.
- Then at each player's turn, they need to put a card of one silo onto the placeholder of the same silo on the board.
- The cards are numbered in order of the months and year. If there are multiple immunizations/cards in an age group, they are numbered  $2^1/5$ ,  $2^2/5$ ,  $2^3/5$ ... and so on. This acts as a cue for the players to know how many more cards are left to complete the current sequence so that they don't miss a card and jump to the next month or sequence.
- If a player successfully places a card in the placeholder silo, the player gets 2 more chances or play rounds as a bonus.

- If there is no possibility of cards being placed or 2 bonus rounds are complete, then the turn goes to the next/following player.
- After one age group is completed, the following players, in their turn, can place cards in one age group upper than the upper set or lower than the lower set on the board.
- The rounds of play continue until all cards are exhausted from a player's hand. The first player to exhaust the holding cards wins the round and is awarded the first rank, followed by the next players until all cards are exhausted by all players.

### **3.7 Limitations of playing with physical cards**

Physical cards have limitations as follows:

- The rules of the play need to be followed in order to achieve the intended learning. However, players need to constantly monitor the activities in order to catch deviations from the rules. This problem can be solved digitally through rules written in the form of algorithms. Every wrong move would be announced through voice cues.
- In India, there are 22 official languages. Different groups have different number literacy levels. Some are comfortable with the script of Devnagri numbers or regional ones, while some are with English numbers. Making customized decks cater to each group won't be scalable.
- The content or the knowledge to be delivered changes with new findings in medical science, which needs to be implemented over the state or country. This translates to adding new cards or scraping off the distributed cards, printing and resupplying new decks to all ASHAs, which is not a scalable solution.
- Mundane chores of play, like shuffling cards, equally distributing cards between the number of players, and packing them up, take up a lot of time for players to do it manually by hand. These can be done digitally in almost no time. It can also be done in an animated sequence to mimic the physical action sequence of shuffling, distributing, and packing up, which are very satisfying to watch in an interface.

### **3.8 Designing an app-based interface of the same activity**

In the digital app, there are 4 foundations on the top which represent 4 silos. The players click on the desired card to pick it and click on the empty foundation to drop it. If there are multiple cards to that sequence (like  $2^1/5$ ,  $2^2/5$ ,  $2^3/5\dots$ ), the cards keep stacking over. As soon as the sequence is complete they collapse into the foundation. It opens up the possibility to stack cards over or under, the bigger and smaller cards in sequence respectively. A reference to the app's User Interface is shown in Figure H.1 in the Appendix section.

### **3.9 Multiplayer Playing Variation**

During previous field studies, it was observed that more than half of the ASHAs had access to smartphones but did not own them. Usually, their husbands own it and share it with their wives, the ASHA. The resource constraints of owning a phone individually could be potentially solved if one smartphone could be used by 4 players, turn by turn while 4 players can physically arrange them sitting in a circle. A pass button in the User Interface to skip the turn to the next player was introduced. After each player plays her move in her turn and ends successfully stacking a card, the next player gets the turn. But if there are no moves possible then, the player can click on the Pass button to pass the turn to the next player. The player after completing her turn, orients the phone by turning it towards the next player for her turn to play. Also, an assistive voice would be played announcing the current player's name, to reduce the confusion of which player's turn is it currently.

During previous field studies, it was also observed that the Community Healthcare Workers are comparatively busy during their daytime serving the community, going door to door. It becomes hard for them to manage time to physically get together, sit in a circle, and play the game either digitally or physically. A multiplayer remotely connected play would potentially solve this problem. In this case, one of the players creates a server generally called a "Room" having a meaningful name representing the team. The rest of the players connect to that room and the creator of the room starts the game. Similar mechanics are followed. The players get an opportunity to put cards in their turn. When the turn is passed, the moves get frozen until the

turn comes all over again completing all the other players.

During trials, with remotely connected players we observed that there were a lot of misunderstandings due to the lack of communication between players. They felt frustrated if they couldn't perform a task due to the restrictions enforced by the rules of play, for example when the turn was missed or couldn't place a card in their turn, etc. So we introduced audio communication similar to a radio which broadcasts audio of one player to all other players connected in the room or with the other player forming a group with the player. We observed peer learning happening through the discussions between the players while explaining the rules to one another and in general team conversations.

Following the same game mechanics, rules, and deck of cards, two variations of the Android game app were developed. The gameplay analytics of each player would be saved offline and asynchronously stored in an online database whenever the internet would be available, for further analysis. ASHAs having an active data connection would update the scores instantly. It was observed that a number of ASHAs didn't have an active data pack in their smartphone. For them, there would be asynchronous syncing multiple times within a week, whenever she would come to the state institution for reporting and would connect her smartphone to the Wi-Fi network of the institution (which is usually available).



# **Chapter 4**

## **Evaluation**

### **4.1 Evaluation method**

Through this research study, we were able to understand knowledge gain, retention, and satisfaction after playing the designed game with the intervention group and compare it with a control group with the traditional mode of the classroom refresher course. The evaluation of the game-play intervention program generally follows the Kirk Patrick Model of Evaluation (Kirkpatrick, 1950). This model considers evaluation across four levels

1. Level 1: Reaction,
2. Level 2: Learning,
3. Level 3: Behavior, and
4. Level 4: Impact/Results.

The scope of this research study will be limited to conducting level 1 and level 2 evaluations only, as level 3 and 4 evaluates the prolonged effects of the intervention program.

1. Kirk Patrick Level 1 evaluation (Reaction): CHWs' reaction toward the game, gameplay experience, enjoyment, and satisfaction after playing a few rounds of the game will be recorded through feedback forms. The standard SUS questionnaire for evaluating usability covers most of the Level 1 questions. The responses would provide inputs for further modification of the game. The GEQ or Game Experience Questionnaire (Ijsselsteijn et al., 2013) was translated into Indian languages. We started with Marathi and Hindi as the respondents were majorly into these two languages.
2. Kirk Patrick Level 2 evaluation (Learning): A pre and post-questionnaire on both intervention and control groups will assess the delta learning by measuring the change in the CHWs' knowledge of child immunization and pregnancy care. To compare if the delta learning is significantly different in one of the cases, a paired 2-sample t-test (considering normal distribution) was conducted. The post-test was further compared to another post-test done a week later to compare knowledge retention. Similar t-tests were conducted to find significant differences.

The digital game of sorting immunization cards can be compared with the traditional classroom settings. ANOVA for multiple comparison of means and Tukey test to compare pairwise differences or Dunnett's test to compare each group mean to a control mean can be conducted.

An attempt could be made to check Level 3 or Behavior changes by shadowing the CHWs in immunization camps and understanding the knowledge and attitude about immunization, pre and post-intervention. Qualitative studies like coding the daily experiences of each persona, might show some changes. Level 4 changes like change in the percentage of child immunization in large health surveys conducted pre and post-intervention, would have too many co-factors, and measuring the changes would not be exclusive of the intervention.

Apart from learning gains and knowledge retention tests, usability testing and evaluation of this method of learning could be performed.

1. Usability Testing of the designed game (Jakob Nielsen)
  - (a) Learnability : How easy is it for a new player to learn how to interact with the interface of the digital game

- (b) Memorability : If the player comes back after some time to play the same game, how easy is it to regain proficiency or to remember what they have learned, the first time they played the game
- (c) Efficiency : Once players have used the interface or the system, how quickly can they perform different tasks
- (d) Accuracy : How often do players make mistakes related to the rules
- (e) Satisfaction : How is the experience of playing the game? Are the players having fun, enjoying, feeling skilled, gaining mastery, providing context for social interaction, etc?

### **4.1.1 Participants**

Prior notification of conducting these field testing sessions was given to the ASHA coordinator and Health Officers of Burhanpur Urban (Burhanpur, Madhya Pradesh), Joka village (Kolkata, West Bengal), and Mandala village (Slum near BARC, Mankhurd, Mumbai). ASHAs were recruited in this research through snowball sampling (Goodman, 1961). The demographics of the participants are tabulated in Table: C.1. Participation in the playtesting activity is voluntary, with an option to quit anytime during the research. ASHAs were tried to be compensated for the valuable time and expertise they brought in. Their contribution to our research was immeasurable materialistically. As a token of gratitude, tea, snacks, and sweets were served. Another arm of the experiment was conducted among nursing students of 2 years of ANM and 4 years of Bsc Nursing at the Seva Mandal Education Society's, Smt. Sunanda Pravin Gambhirchand College of Nursing, located at Matunga, Mumbai.

### **4.1.2 Instrumentation**

#### **4.1.2.1 Core Knowledge Questionnaire**

The instrument used in this study had three sections. All participants expressed their consent to this research by reading the first section of the questionnaire and signing it before every

survey/test. The second section was the demographic data sheet to identify potential group variances. The demographic data sheet consisted of a checklist and gap-fill questions such as age, highest educational grade/degree, and years of experience as an ASHA. The third section was 40 Multiple Choice Questions (MCQ) on all 4 silos, Children below 1 year, above 1 year, ANC and PNC. Questions related to infants and children were on immunization and medicine supplements. This test evaluates the participants' knowledge at the baseline, knowledge gained through intervention, and knowledge retention after a week of practicing the playful activity. A reference to the 3-page questionnaire is in the Appendix section: (Figure: B.1 , B.2 and B.3) in the Appendix Section. This questionnaire was initially prepared in English and then auto-translated to Indian languages by Google translation services followed by human corrections. Initially, it was translated to Hindi, Marathi, and Bengali as most of the respondents' mother tongue majorly comprised of these languages.

#### **4.1.2.2 Game Experience Questionnaire**

We tried to conduct the game experience survey through the GEQ (Game Experience Questionnaire) (Ijsselsteijn et al., 2013). The questionnaire contains 33 questions assessing the experience of gaming on seven components: Immersion, Flow, Competence, Positive and Negative Affect, Tension, and Challenge. There are approximately 5 questions per item to make it a robust experience measure. The questions generally try to capture the feelings that they experienced while gaming. The answers are on 5 points Likert scale which ranges from "not at all" at the low to "extremely" at the higher end. The GEQ is currently available in global Western languages like English, Dutch, Finnish, and German (Ijsselsteijn et al., 2008). In this research, an attempt was made to translate it into Indian languages. We started with Marathi and Hindi as the respondents were majorly into these two languages. The translation process of GEQ was similar to the translation process of the main evaluation questionnaire. Firstly we translated the English texts to Marathi with the help of Google Translation service and IndiaTyping service, to get two linguistic variations. Then a human was involved in correcting the questions' translation one by one. As Indian languages are cultural and gender-sensitive, it was considered that the questions were being asked to an elderly lady in a formal or respectful manner. The choice of vocabulary was chosen so that it is appropriate for the rural respondent, thus avoiding urban lingos. For simplicity of understanding English words in Marathi texts were used which

are commonly used by local people. A reference to the GEQ and the translation process is in the Appendix Section (Figure : B.4). Later, the GEQ is now in the process of translation into 16 Indian languages: Bengali, Gujarathi, Hindi, Kannada, Malayalam, Marathi, Tamil, Telegu, Odiya, Punjabi, Urdu, Assamese, Nepali, Bhojpuri, Konkani and Maithili. The translated questionnaires are going through rounds of human correction phases.

One of the contributions by the end of this research is the GEQ Analysis Toolkit for analyzing qualitative GEQ feedback. When a user inputs the 33 questionnaire survey results, conducted physically or digitally in the field, converted into a CSV format, an analysis will be conducted through algorithms coded on Python at the backend and generate charts and inferences. Firstly, it fixes the negative questions into inverse values. Then it generates a color-coded correlation matrix between all questions. Then it generates another correlation matrix of the broader themes or seven components.

We left the social presence module as it checks the involvement of a player socially, like with the in-game characters, and the post-game module checks the fatigue or resentment after the player has not played the game for a long time. These 2 modules were beyond the scope of this research, so were excluded.

#### **4.1.2.3 Data Collection method**

A baseline knowledge evaluation was conducted before the intervention. Then 4-5 rounds of physical card play were conducted. It was followed by a post-test using the questionnaire survey. A deck of cards was given to every 4-ASHA group who lived in close vicinity. They were encouraged to play when they met for about an hour every day for a week. After a week, the knowledge levels were again tested using the questionnaire survey.

#### **4.1.3 Ethics Declaration**

All study procedures were approved by the IIT Bombay Institutional Review Board (IRB) (Proposal Number: IITB-IRB/2022/051) and the IRB approval is attached in the Appendix (Figure : I.1) . All participants provided informed consent prior to data collection. All methods were carried out in accordance with relevant guidelines and regulations set by the Institute Ethics

Committee which strictly adheres to the Declaration of Helsinki developed by the World Medical Association.

# **Chapter 5**

## **Results and Discussions**

### **5.0.1 Analysis and Results**

#### **5.0.1.1 Arm 1 Study: Burhanpur - ASHA Workers for physical card version**

In summary, knowledge levels were checked in three intervals: Pre-intervention, Immediately Post-intervention, and After a week. The summary of the results of the 3 tests is tabulated in Table: D.1 appended in the Appendix Section. The score data collected through the questionnaire survey is visualized through Box Plot in Figure: D.1. The histograms of score data collected at 3 intervals are visualized in distribution curves in Figure: E.1. The three histograms with distribution curves are combined in the Figure: E.2.

Before conducting any parametric tests on the data, the normality or normal distribution of data should be checked. While there are multiple kinds of normality tests, the Anderson-Darling Test is the most reliable and most commonly used. The test was performed for all 3 interval data/scores groups. The P value was found to be greater than .05, which indicates that the data is normal. A reference to the normality test is shown in Figure E.3 in the Appendix.

In order to check if there was a significant difference between scores, 1 sample paired t-test between the scores was conducted. 3 groups were paired in combination with 2 and tested for significant differences. The results are tabulated in Table: E.4 in the Appendix section..

The pre-test scores differed significantly from both the post-tests, signifying a significant knowledge gain through the intervention (between the baseline survey and post-test survey). The mean difference between the two score groups was found to be 6.37 . A test was conducted to check, at what difference of scores the improvement is significant. Starting from 1, the test was repeated by raising the difference and found that the difference is significant (95% CI) till  $\geq 5$  but fails at 6. A reference to this paired t-test is shown in Figure E.5 in the Appendix section.

There was a significant difference between the two post-tests (immediately after the intervention and a week after the intervention), but the p-value was less signifying a marginal loss of knowledge due to refreshing knowledge by playing with the cards throughout the week. The mean difference between the two score groups was found to be 1. A test was conducted to check, at what difference of scores the improvement is significant. Starting from 0, the test was repeated by raising the difference and found that the difference is significant (95% CI) till  $\leq 0.5$  but fails at 0.6. A reference to this paired t-test is shown in Figure E.6 in the Appendix section.

There were no statistical difference ( $P > 0.7$ ) or high correlation ( $R^2 = 0.00005$ ) patterns found between factors like age, years of formal education, experience as an ASHA, and the scores obtained in each test or the delta learning between intervention phases.

All statistical analyses were performed in Minitab (Version 21.2) and the data or results are visualized using the website Flourish Studio.

#### **5.0.1.2 Arm 3 Study: Mumbai - Nursing Students**

The first-year ANM batch (n=39, Average Age=19 years, SD=2.28) had recently joined the course in the last 2 months. They didn't have any prior knowledge about immunization. They mostly did guesswork filling out the pretest questionnaire. Conducting t-tests we found no significant difference between the pre and post-test of the physical card group [ $p=0.197$  almost 0.2, average improvement in scores = 4.6] but was significant in the digital group [ $p=0.0009$ ,

average improvement in scores = 16.5]. As the intent of this research is to study the effectiveness of the tool, particularly as a refresher training, this cohort does not match well with the requirements. However, we see promising improvements in results in the digital group.

The second-year ANM batch (n=29, Average Age=20.25 years, SD=2.25) had been taught immunization as coursework. There was a significant difference in both the physical card group [n=19, p=0.003, average improvement in scores = 3.63, SD=4.7] and the digital app group [n=10, p=0.002, average improvement in scores = 8.5, SD=6.4]. The digital app group performed better but there was a large variation in the scores. So a t-test between the differences in the card and digital app groups was performed. It shows that the differences are not significant (p=0.051). Though there is a significant improvement in scores from pre to post-test for both groups, we cannot conclude that both interventions had a significant difference between them.

The First and Second-year BSc Nursing batches were excluded from the study calculations as they were not taught immunization in their coursework yet. 4th Year batches were recruited in clinical practices in hospitals, so were not reachable. So we decided to conduct the study only on the 3rd Year BSc Nursing batch (n=35, Average Age=20.94 years, SD=1.14) who had been taught immunization in the coursework. There was a significant difference in pre and post-tests within the groups for both the physical card group [n=25, p=0.0000007, average improvement in scores = 9.16, SD=6.88] and the digital app group [n=10, p=0.00005, average improvement in scores = 12.3, SD=5.38]. The digital app group performed better but there was a large variation in the scores. So a t-test between the differences in the card and digital app groups was performed. It shows that the differences are not significant (p=0.17). Though there is a significant improvement in scores for both groups, we cannot conclude that both interventions had a significant difference between them and ineffective refresher training. The findings are visualized using box plots shown in Figure E.7 in the Appendix section.

The GEQ was first tested on this cohort, 3rd Year BSc Nursing batch. The questions were analyzed and represented in a correlation matrix shown in Figure E.8 in the Appendix section.

#### **5.0.1.3 Arm 4 Study: Burhanpur - ASHA Workers for digital or Android version**

The second phase of the study with the digital game app was conducted in Burhanpur with a different sample (n=30).

The study results are yet to be analyzed. I'll update this section with a comparison of the physical card game results and digital game app results.

## 5.0.2 Discussion

In summary, the playful activity with immunization cards was found to be significantly effective for refresher training of ASHAs with significant knowledge retention. The results were compared by repeating the experiment with both groups. The digital card mode was found to be significantly better in most cases except in a few.

There is a subtle trend that shows that with growing age the delta change in knowledge gains between pre and post-test was getting lower. However, in this research, the trend was not found significant with a 95% confidence interval. Research on learning in other contexts also finds similar results. Years of formal education also have an insignificant effect on baseline score, as the knowledge or experience gained mostly depends on the years of experience, working in the field as an ASHA worker, and having hands-on experience dealing with common issues. As a large number of ASHAs were in the category of 9-10 or more years of experience, a grouped comparison between them and the rest minority would not be statistically significant.

While checking the questionnaire survey, a lot of mismatches regarding the standardization of information were found. 2 questions on Rotavirus were found to be ignored by a lot of ASHAs. On further investigation, it was found that the Rotavirus vaccines were not operational in the entire state of Madhya Pradesh and thus also not included in the printed brochures. Some of the ASHAs made mistakes in the PCV booster. On further investigation it was found that the term "booster" was not mentioned for any of the vaccines in the schedule they were trained with, thus creating confusion. But most of them understood and answered it right. 3 ASHAs were caught in the malpractice of cheating from their job aid immunization schedule during the baseline survey. They were excluded from the statistical evaluation calculations. In this study design, the same questionnaire was used for all 3 rounds of survey. In the next phase, the order of questions was randomized to minimize the question's positional effect and order remembrance. 3 sets of questionnaires were made for each language with a randomized order of questions.

Some ASHAs, especially the ones with low formal education, faced difficulty with reading Hindi numbers printed on the cards as well as while filling out the survey questionnaire. In the next phase, the numbers were changed to English and the words in Hindi were unchanged. There were some ASHAs who studied in a Madrasa and could only recognize English and Urdu numbers. They required translation of the numbers in English in order to fill out the form but still managed to play cards as the rest of the information on the card was enough to play. So in the next phase, we changed all numbers in the card and the app to English numbers.

Focused Group Discussions with ASHAs reveal a lot of information about their lives and daily activities, which usually gets masked behind the top-down bureaucratic framework, within which they work. Some of the ASHAs reported that the ANM is responsible for the immunization and the ASHA is mostly responsible for community mobilizing, co-ordinating, and assisting with the ANM. In spite of that, any mistake committed by the ANM like wrong or missed immunization, or not practicing standards of hygiene, is often blamed on the lower-level vulnerable position, which in this case happens to be an ASHA. But still, an ASHA does her best to provide the right kind of assistance required by the ANM and the community. If the ASHAs could be trained with frequent refresher training, they could help minimize these faults in their daily job to a large extent, thus strengthening community healthcare services. Most ASHAs have an intrinsic motivation to learn about healthcare and provide better care for the community. In spite of the selfless efforts put in by the ASHAs, they used to be rarely appreciated by the state and sometimes by the community. Recently on 22 May 2022, the WHO Director-General announced ASHAs of India as one of the six awardees of the Global Health Leaders Awards for their crucial role in linking the community with the health system and ensuring those living in rural poverty can access primary health care services in the crucial times of COVID-19 pandemic. The intention here is not to romanticize and idealize the lives and struggles of the ASHAs, but to highlight the immense amount of dedication they show towards their job in spite of often having physical fatigue and sometimes carrying emotional breakdowns as a woman and often as a mother.

### **5.0.3 Limitations of the study**

One of the limitations of this study is the gender, religion, class, and caste positionality of the researcher vis-a-vis the ASHAs engaged in the study. The best practices and standards of research were followed including the community in iterative feedback loops to validate the collected data and its interpretation. As a future step, there are plans to engage with multiple community stakeholders through our research insights to collaboratively explore if and how digital training interventions could be designed to enhance ASHA refresher training, knowledge gains, and retention.

The experiment was conducted in a formal institution environment of a healthcare centre. The job profiles of the ASHAs, the participants, or players of this experimental research are voluntary field functionaries or street-level bureaucracies. ASHAs are a cadre of CHWs of the state, under which they are obliged to act or function within the framework of the top-down bureaucracy.

### **5.0.4 Proposed Design of a Randomised Controlled Trial**

We would like to repeat the experimental study again with the next cohort or recruit ASHAs to evaluate the pedagogical impact and investigate the effect of demographics (ie, age, and socio-economic background), and study techniques on long-term knowledge retention. The statistical results of conducting field experiments ( $n=30$ ), in the current study have led us to calculate the variables required for conducting a Randomized Control Trial (RCT).

The sample size was calculated by using G\* power 3.0 software (Faul et al., 2007). In this study, comparisons between groups with t-tests (one tail) for independent samples, medium effect size ( $d = .50$ ), and a sample of 65 participants in each group would be required to achieve 99% power to detect a difference at 0.05 significance level (Polit, 2014). For conducting 2 experiments with 2 groups (control and experiment), 130 participants would be required. Considering the attrition rate of 10% during the phased experiment and evaluation process, the calculated sample size required to have a significant effect would be 145-150 ASHAs. A reference to the calculation is demonstrated in Figure E.9.

Pre, Post, and Long Term Post Tests (after 6 months) would be conducted to measure knowledge gained through playing sessions and retained for a long time. Game-related indicators like fun, engagement, satisfaction, and immersion will also be measured for both interventions.



# **Appendix A**

## **Tables**

Vaccine Name	Birth	$1\frac{1}{2}$ months	$2\frac{1}{2}$ months	$3\frac{1}{2}$ months	9 months	$1\frac{1}{2} - 2$ years
BCG	✓					
Hepatitis B	✓					
OPV	✓	✓	✓	✓		✓
IPV		✓		✓		
Penta		✓	✓	✓		
PCV		✓		✓	✓	
Rota		✓	✓	✓		
MR					✓	✓
JE					✓	✓
DPT						✓

Table A.1: Child Immunization schedule



## **Appendix B**

### **Survey Questionnaire**

मैं अपनी हस्ताक्षर के माध्यम से  
स्वीकार करती हूं कि इस शोध  
अध्ययन में मेरी भागीदारी  
स्वैच्छिक है। मैं इस तथ्य से  
अवगत हूं कि एकत्र की गई  
व्यक्तिगत जानकारी का उपयोग  
केवल शैक्षिक उपयोग के लिए  
किया जाएगा।

\_\_\_\_\_ / \_\_\_\_\_ / २०२२  
**हस्ताक्षर**                    **तिथि**

नीचे दी हुई जगह पर अपना पूरा नाम लिखिए :

अपनी उम्र लिखिए : \_\_\_\_\_ साल

आपकी स्कूली शिक्षा कौनसी श्रेणी तक हुई है :  
 ८ वि     ९ वि     १० वि     ११ वी  
 १२ वि     ग्रेजुएट     पोस्ट-ग्रेजुएट

आप कितने वर्षों से आशा कार्यकर्ता हैं :

\_\_\_\_\_ साल

कृपया निम्नलिखित प्रश्नों के उत्तर  
खाली बक्सों में  निशान लगाकर दीजिये ।  
प्रत्येक प्रश्न का केवल एक ही सही उत्तर है ।

१. ओ पी वी - बूस्टर शिशु को किस आयु मैं दिया जाता है ?

- १ महीने     १ १/२ साल  
 २ साल     ३ १/२ साल

२. पेंटावैलेट - १ टीका शिशु को किस आयु मैं दिया जाता है ?

- १ १/२ महीने     २ १/२ महीने  
 ३ १/२ महीने     ९ महीने

३. एम आर - १ (खसरे का पहला टीका) शिशु को किस आयु मैं दिया जाता है ?

- १ महीने     १ १/२ साल  
 २ साल     ३ १/२ साल

४. पहला डीपीटी बूस्टर शिशु को किस आयु मैं दिया जाता है ?

- १ महीने     १ १/२ साल  
 २ साल     ३ १/२ साल

५. दूसरा डीपीटी बूस्टर शिशु को किस आयु मैं दिया जाता है ?

- १ महीने     १ १/२ साल  
 ५-६ साल     ३ १/२ साल

६. टी टी / टी डी (टेटनेस / डिष्टोरिया) का पहला टीका शिशु को कौनसी आयु मैं दिया जाता है ?

- १० साल     १६ साल  
 ६ साल     ५ साल

७. टी टी / टी डी (टेटनेस / डिष्टोरिया) का दूसरा टीका शिशु को कौनसी आयु मैं दिया जाता है ?

- १० साल     १६ साल  
 ६ साल     ५ साल

८. पेंटावैलेट - २ टीका शिशु को किस आयु मैं दिया जाता है ?

- १ १/२ महीने     २ १/२ महीने  
 ३ १/२ महीने     ९ महीने

Figure B.1: Questionnaire Page-1

१. विटामिन ए सबसे पहले बच्चों को कब दिया जाता है?

१ महीने  १ १/२ साल

२ साल  ३ १/२ साल

२०. विटामिन ए दूसरी बार बच्चों को कब दिया जाता है?

१ महीने  १ १/२ साल

२ साल  ३ १/२ साल

२१. दूसरी बार के बाद विटामिन ए बच्चों को किस अंतराल में दिया जाता है?

३ महीने  ४ महीने

५ महीने  ६ महीने

२२. एम आर - २ (खसरे का दूसरा टीका) शिशु को कब दिया जाता है?

१ महीने  १ १/२ साल

२ साल  ३ १/२ साल

२३. जे ई - १ (जापानीज इन्सेफेलाइटिस) का पहला टीका शिशु को कब दिया जाता है?

१ महीने  १ १/२ साल

२ साल  ३ १/२ साल

२४. जे ई - २ (जापानीज इन्सेफेलाइटिस) का दूसरा टीका शिशु को कब दिया जाता है?

१ महीने  १ १/२ साल

२ साल  ३ १/२ साल

२५. पी सी वी - १ (न्यूमोकोकल कंजुगेट) का पहला टीका शिशु को कब दिया जाता है?

१ १/२ महीने  २ १/२ महीने

३ १/२ महीने  १ महीने

२६. पी सी वी - २ (न्यूमोकोकल कंजुगेट) का दूसरा टीका शिशु को कब दिया जाता है?

१ १/२ महीने  २ १/२ महीने

३ १/२ महीने  १ महीने

२७. पी सी वी - बूस्टर शिशु को कब दिया जाता है?

१ १/२ महीने  २ १/२ महीने

३ १/२ महीने  १ महीने

२८. पेंटावैलेट - ३ टीका शिशु को किस आयु मैं दिया जाता है?

१ १/२ महीने  २ १/२ महीने

३ १/२ महीने  १ महीने

२९. हेपेटाईटिस बी टीका शिशु को कब दिया जाता है?

जन्म  १ १/२ महीने

२ महीने  ३ १/२ महीने

३०. रोटा - १ (रोटावायरस) का पहला टीका शिशु को कब दिया जाता है?

जन्म  १ १/२ महीने

२ महीने  ३ १/२ महीने

३१. बी सी जी का टीका शिशु को कब दिया जाता है?

जन्म  १ १/२ महीने

२ महीने  ३ १/२ महीने

३२. रोटा - २ (रोटावायरस) का दूसरा टीका शिशु को कब दिया जाता है?

जन्म  १ १/२ महीने

२ महीने  ३ १/२ महीने

३३. ओ पी वी - ० (ओरल पोलियो वैक्सीन) का पहला टीका शिशु को कब दिया जाता है?

जन्म  १ १/२ महीने

२ महीने  ३ १/२ महीने

३४. रोटा - ३ (रोटावायरस) का तीसरा टीका शिशु को कब दिया जाता है?

जन्म  १ १/२ महीने

२ महीने  ३ १/२ महीने

३५. जन्म के तुरंत बाद शिशु को क्या दिया जाना चाहिए?

कोलोस्ट्रम  ओ पी वी - ०

हेपेटाईटिस बी  बी सी जी का टीका

Figure B.2: Questionnaire Page-2

<p>२६. ओ पी वी - १ (ओरल पोलियो वैक्सीन) का दूसरा टीका शिशु को कब दिया जाता है?</p> <p><input type="checkbox"/> जन्म    <input type="checkbox"/> १ १/२ महीने</p> <p><input type="checkbox"/> २ महीने    <input type="checkbox"/> ३ १/२ महीने</p>	<p>३४. किस प्रसवपूर्व देखभाल पर गर्भवती माँ को टी टी - २ (टिटेस टॉक्साइड) का दूसरा इंजेक्शन दिया जाता है ?</p> <p><input type="checkbox"/> पहला    <input type="checkbox"/> दूसरा</p> <p><input type="checkbox"/> तीसरा    <input type="checkbox"/> चौथा</p>
<p>२७. आई पी वी - १ (इनएक्टिवेटेड पोलियो वैक्सीन) का पहला टीका शिशु को कब दिया जाता है?</p> <p><input type="checkbox"/> जन्म    <input type="checkbox"/> १ १/२ महीने</p> <p><input type="checkbox"/> २ महीने    <input type="checkbox"/> ३ १/२ महीने</p>	<p>३५. टीटी बूस्टर उन गर्भवती माताओं को दी जाती है जिन्होने पिछले कितनी सालों में टीटी के २ टीके लगवा चुकी है ?</p> <p><input type="checkbox"/> १    <input type="checkbox"/> २</p> <p><input type="checkbox"/> ३    <input type="checkbox"/> ४</p>
<p>२८. ओ पी वी - २ (ओरल पोलियो वैक्सीन) का दूसरा टीका शिशु को कब दिया जाता है?</p> <p><input type="checkbox"/> जन्म    <input type="checkbox"/> १ १/२ महीने</p> <p><input type="checkbox"/> २ महीने    <input type="checkbox"/> ३ १/२ महीने</p>	<p>३६. किस प्रसवपूर्व देखभाल पर गर्भवती माँ को आयरन फोलिक एसिड (आई एफ ए) की गोलियां सेवन चालू करनी चाहिए ?</p> <p><input type="checkbox"/> पहला    <input type="checkbox"/> दूसरा</p> <p><input type="checkbox"/> तीसरा    <input type="checkbox"/> चौथा</p>
<p>२९. पेंटावैलेंट - २ टीका शिशु को किस आयु मैं दिया जाता है?</p> <p><input type="checkbox"/> १ महीने    <input type="checkbox"/> १ १/२ साल</p> <p><input type="checkbox"/> २ साल    <input type="checkbox"/> ३ १/२ साल</p>	<p>३७. गर्भवती महिलाओं को कौन सी कृमिनाशक गोली दी जाती है ?</p> <p><input type="checkbox"/> कैल्शियम    <input type="checkbox"/> एल्बेंडाजोल</p> <p><input type="checkbox"/> आई एफ ए    <input type="checkbox"/> विटामिन डी</p>
<p>३०. ओ पी वी - ३ (ओरल पोलियो वैक्सीन) का दूसरा टीका शिशु को कब दिया जाता है?</p> <p><input type="checkbox"/> जन्म    <input type="checkbox"/> १ १/२ महीने</p> <p><input type="checkbox"/> २ महीने    <input type="checkbox"/> ३ १/२ महीने</p>	<p>३८. आई एफ ए गोलि के साथ किस गोलि का सेवन नहीं करना चाहिए ?</p> <p><input type="checkbox"/> कैल्शियम    <input type="checkbox"/> एल्बेंडाजोल</p> <p><input type="checkbox"/> आई एफ ए    <input type="checkbox"/> विटामिन डी</p>
<p>३१. आई पी वी - २ (इनएक्टिवेटेड पोलियो वैक्सीन) का पहला टीका शिशु को कब दिया जाता है?</p> <p><input type="checkbox"/> जन्म    <input type="checkbox"/> १ १/२ महीने</p> <p><input type="checkbox"/> २ महीने    <input type="checkbox"/> ३ १/२ महीने</p>	<p>३९. सिफलिस टेस्ट और एचआईवी टेस्ट किस प्रसवपूर्व देखभाल पर गर्भवती माँ को करवाना चाहिए ?</p> <p><input type="checkbox"/> पहला    <input type="checkbox"/> दूसरा</p> <p><input type="checkbox"/> तीसरा    <input type="checkbox"/> चौथा</p>
<p>३२. एक गर्भवती माँ को अपनी पूरी गर्भावस्था में कितने न्यूनतम प्रसवपूर्व देखभाल सत्रों की आवश्यकता होती है ?</p> <p><input type="checkbox"/> १    <input type="checkbox"/> २</p> <p><input type="checkbox"/> ३    <input type="checkbox"/> ४</p>	<p>४०. पहला प्रसव पश्चात देखभाल कितने घंटों के भीतर करना चाहिए?</p> <p><input type="checkbox"/> ४    <input type="checkbox"/> ६</p> <p><input type="checkbox"/> १२    <input type="checkbox"/> २४</p>
<p>३३. किस प्रसवपूर्व देखभाल पर गर्भवती माँ को टी टी - १ (टिटेस टॉक्साइड) का पहला इंजेक्शन दिया जाता है ?</p> <p><input type="checkbox"/> पहला    <input type="checkbox"/> दूसरा</p> <p><input type="checkbox"/> तीसरा    <input type="checkbox"/> चौथा</p>	

Figure B.3: Questionnaire Page-3

	A Sl	B English	C IndiaTyping	D Google	E Corrected Human	F Reverse Translated
2	1 I felt content	मला समाधान वाटले	मला समाधी वाटली	मला समाधान वाटले	I was satisfied	
3	2 I felt skillful	मला कुशल वाटले	मला कुशल वाटले	मला कुशल वाटले	I felt very skilled because of the game	
4	3 I was interested in the game's story	मला खेलाच्या कंतेत रस होता	मला खेळाच्या कंतेत रस होता	या खेळामधील गाई साठी मी उत्सुक होते	I was looking forward to the things in this game	
5	4 I thought it was fun	मला वाटले गंतव आहे	मला वाटले की ते गंतव आहे	मला हा खेळ गंतव वाटली	I had this game of fun	
6	5 I was fully occupied with the game	मी खेळत पूर्णपणे गुंतले होते	मी खेळाने पूर्णपणे तात्पात्र बेत होते	मी खेळमध्ये पूर्ण देण्य झालेले	I was full of timber in the game	
7	6 I felt happy	मला आनंद वाटले	मला आनंद वाटला	मला आनंद वाटला	I was happy	
8	7 It gave me a bad mood	मला वाईट मूड दिला	यामुळे मला एक वाईट मूड दिला	याच्यामुळे मला वाईट अनुभव आला	I had a bad experience because of this	
9	8 I thought about other things	मी इतर गोष्टीचा विचार केला	मी इतर गोष्टीबदल विचार केला	मी खेळताना दूसर्या गोष्टीचा विचार करत होते	I was thinking of other things while playing	
10	9 I found it tiresome	मला ते कंठाळवाणी वाटले	मला ते कंठाळवाणी वाटले	मला हा खेळ वाटला	I found this game tiring	
11	10 I felt competent	मला सक्षम वाटले	मला सक्षम वाटले	मला सक्षम असत्यासारख वाटले	I felt like I was able to	
12	11 I thought it was hard	मला वाटले ते कठीण आहे	मला वाटले ते कठीण आहे	मला वाटले ते कठीण आहे	I thought it was hard	
13	12 It was aesthetically pleasing	ते सोंदरविन सुखावाणरे होते	हे सोंदर्यामाकहून आनंदाद्यक होते	खेळ दिसायला सुंदर आणि आकर्षक होता	The game was pretty and attractive to see	
14	13 I forgot everything around me	मी माझा आजवाहाजून सर्व काही विसरले	मी माझ्या सभीवालेच सर्व काही विसरले	मी सगळ विसरून खेळत आकंठ बुडाले	I forgot all about the game	
15	14 I felt good	मला वर वाटले	मला वर वाटले	मला छान वाटले	I would like to feel nice	
16	15 I was good at it	मी त्यात चांगला होतो	मी त्यात चांगला होतो	मला खेळात गर्ती होती	I had a speed in the game	
17	16 I felt bored	मला कंठाळा आला	मला कंठाळा आला	मला कंठाळा आला	I got bored	
18	17 I felt successful	मला वरशी वाटले	मला वरशी वाटले	मला वरशी वाटले	I felt successful	
19	18 I felt imaginative	मला कल्पनाच्या वाटले	मला काल्पनिक वाटले	मझ्या कल्पनाशक्ती ला चालना मिळाली	My imagination got a walk	
20	19 I felt that I could explore things	मला वाटले की मी गोष्टी शोधू शकतो	मला वाटले की मी गोष्टी शोधू शकतो	मला असा वाटले की मी पाण गोष्टी शिकू शकते	I think I can learn things but	
21	20 I enjoyed it	मला जाण आली	मी त्याचा आनंद घेतला	मी इंजीय केला	I did the enjoy	
22	21 I was fast at reaching the game's targets	मी खेळाचे लक्ष्य गाठण्यात जलद होते	मी खेळाच्या लक्ष्यात पोहोचण्यात वेगवान होते	मी खेप वेणारे एक की टप्पा पार करत होते	I was crossing a key phase very fast	
23	22 I felt annoyed	मला चीड वाटली	मला दवाव वाटला	मला दवाव वाटले	I feel very annoying	
24	23 I felt pressurised	मला दवापण जाणवले	मला दवाव वाटला	मला दवाव जाणवला	I feel the pressure	
25	24 I felt irritable	मला चिडवित वाटली	मला चिडवित वाटले	खेळताना माझी चिडवित झाली	I got irritated while playing	
26	25 I lost track of time	मी वेळेचा नाहीतो गमवतला	मी वेळेचा नाहीतो गमवतला	मी वेळेचा नाहीतो भान विसरले	I forgot about the idea of time while playing	
27	26 I felt challenged	मला आढळन वाटले	मला आढळन वाटले	मला खेळ आवश्यानामुक वाटला	I found the game challenging	
28	27 I found it impressive	मला ते प्रभासी वाटले	मला ते प्रभासी वाटले	मला खेळ आकर्षक वाटला	I found the game attractive	
29	28 I was deeply concentrated in the game	मी खेळत मनापासून एकग्र होतो	मी गेममध्ये खोलर लक्ष केंद्रित केले होते	मी खेळ खेळताना सुपू एकग्र झालेले	I	
30	29 I felt frustrated	मला वाटले	मी निराश वाटले	मला खुप निराश वाटले	I felt very frustrated	
31	30 It felt like a rich experience	एक समृद्ध अभ्यास वाटला	हा एक समृद्ध अभ्यास वाटला	हा खुप आलोदाराक अनुभव होता	It was a very pleasant experience	
32	31 I lost connection with the outside world	माझा वाहराच्या जगाशी संपर्क तुटला	मी वाहा जगाशी संवेद्य गमवतला	मी वाकीच्या जगाचा भान विसरले	I forgot about the rest of the world	
33	32 I felt time pressure	मला वेळेचे दवाव जाणवला	मला वेळे दवाव वाटला	मला वेळे दवाव वाटला	I felt the pressure to complete in time	
34	33 I had to put a lot of effort into it	त्यासाठी मला खूप मेहनत घावी लागली	मला खात वेरव करावे लागले	मला खूप मेहनत घावी लागली	I had to work a lot of hard work	
35						
36	34 not at all	अंजिवात नाही	अंजिवात नाही	अंजिवात नाही	Not at all	
37	35 slightly	किंचित	किंचित	किंचित प्रमाणात	Quantitatively	
38	36 moderately	माफक प्रमाणात	माफक प्रमाणात	मध्यम प्रमाणात	To a moderate amount	
39	37 fairly	प्रामाणिकपणे	प्रामाणिकपणे	चांगल्या प्रमाणात	Well	
40	38 extremely	अल्पत	अल्पत	खूप जास्त	Too much	

Figure B.4: GEQ Translation Processs



## **Appendix C**

### **Participants Demographics**

Parameters	Number of ASHAs (%)
Age	
< 30	1 (3.33%)
30 - 39	16 (53.33%)
40 - 49	12 (40.00%)
50 and above	1 (3.33%)
Formal Education (grade)	
10 <sup>th</sup> grade	8 (26.66%)
11 <sup>th</sup> - 12 <sup>th</sup> grade	8 (26.66%)
Graduation	11 (36.66%)
Post-Graduation	3 (10.00%)
Experience as an ASHA worker (years)	
2 - 5	8 (26.66%)
9	6 (20.00%)
10	16 (53.33%)

Table C.1: Participants Demographics (Age, Formal Education, and Experience as an ASHA)

## **Appendix D**

## **Data Collected**

Intervention	Pre-test	Post-test	Post-test after a week
N	30	30	30
Mean Score	19.70	26.07	25.07
Standard Deviation (SD)	5.21	4.53	4.69
P (Normality Test)	0.614	0.635	0.410
1st Quartile	17	23.75	22
Median	19.5	26	25
3rd Quartile	22.75	29.25	27.5
Inter Quartile Range	5.75	5.5	5.5
Minimum	9	17	14
Maximum	30	36	35
Skewness	-0.20	-0.26	-0.20
Kurtosis	0.19	0.62	0.57

Table D.1: Comparison of Pre-test, Post-test, and Post-test (after one week) scores. Learning through playing with Physical cards in groups of 4

## Visualization of Scores of ASHAs

Pre, Post and Post 1 week (n=30)

● Pretest ● Post-test ● Post-test after 1 week

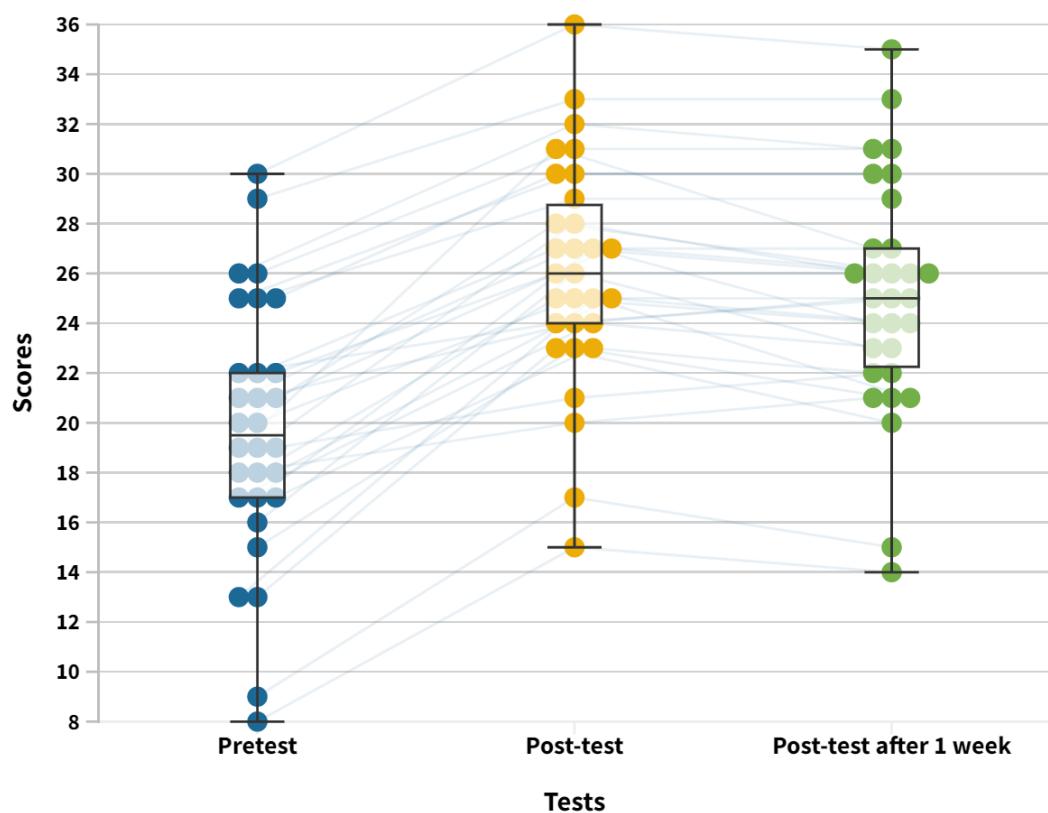


Figure D.1: Comparison of Pre-test, Post-test, and Post-test (after one week) scores

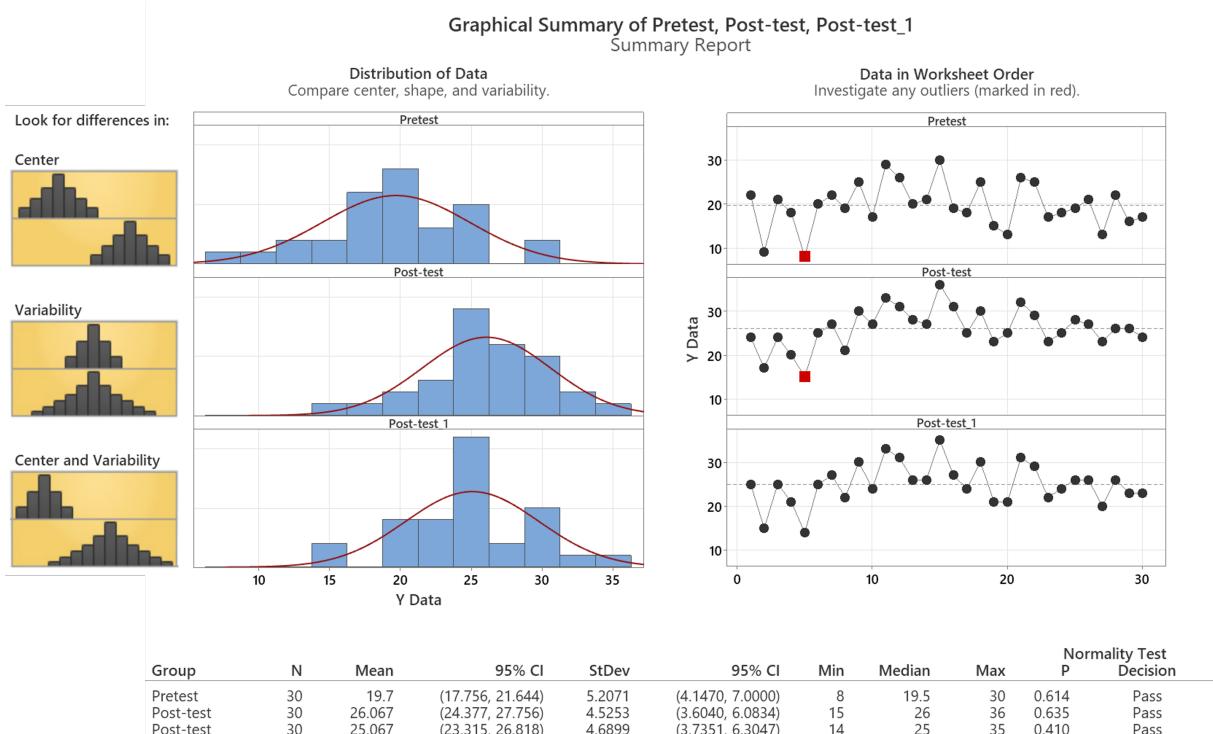


Figure D.2: Summary of 3 groups

## **Appendix E**

## **Data Analysis and Results**

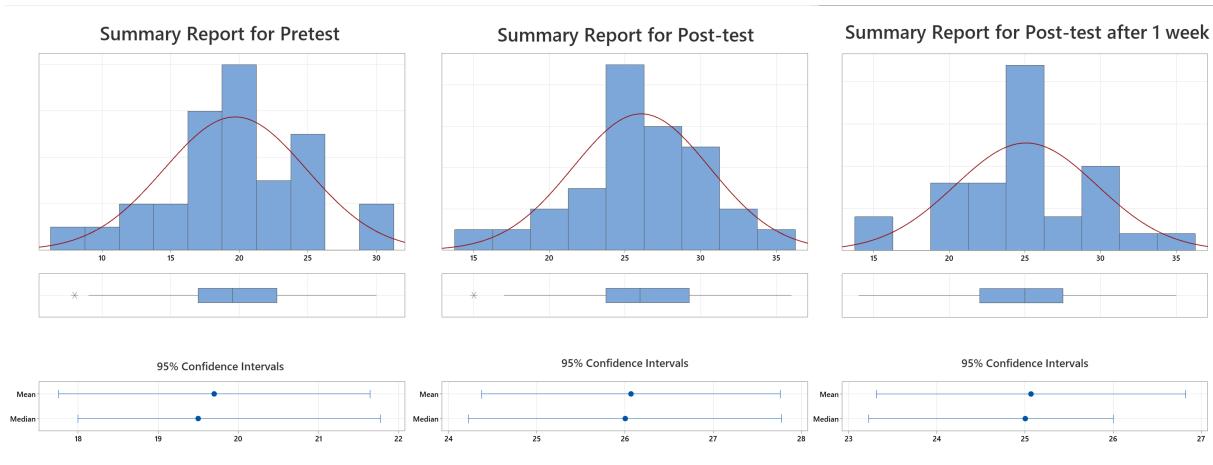


Figure E.1: Comparison of distributions between Pre-test, Post-test, and Post-test (after one week) scores

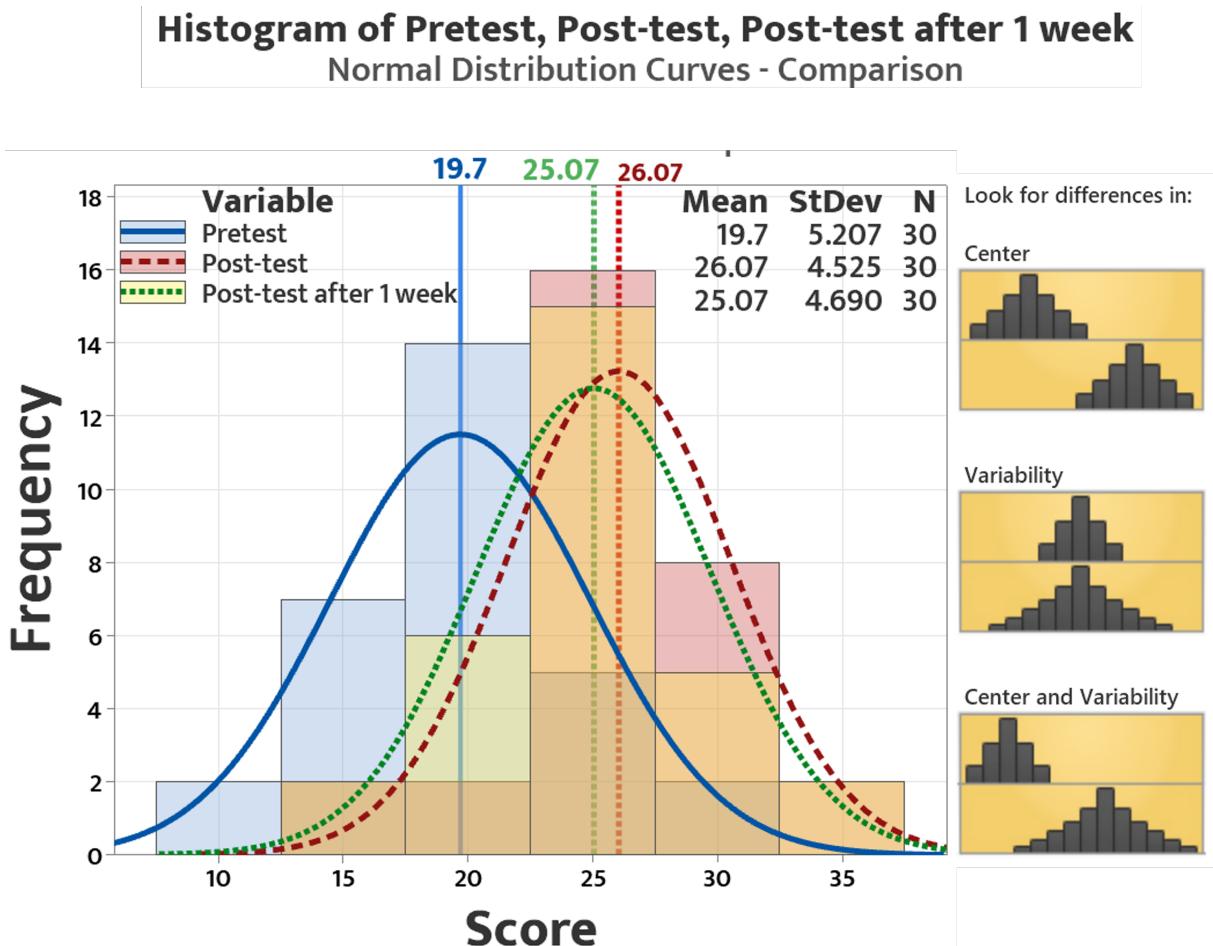


Figure E.2: Combination of above 3 histograms

## Probability Plot - Test for Normality (Normal Distribution)

When  $P > 0.05$  Null hypothesis is accepted that, data is normally distributed

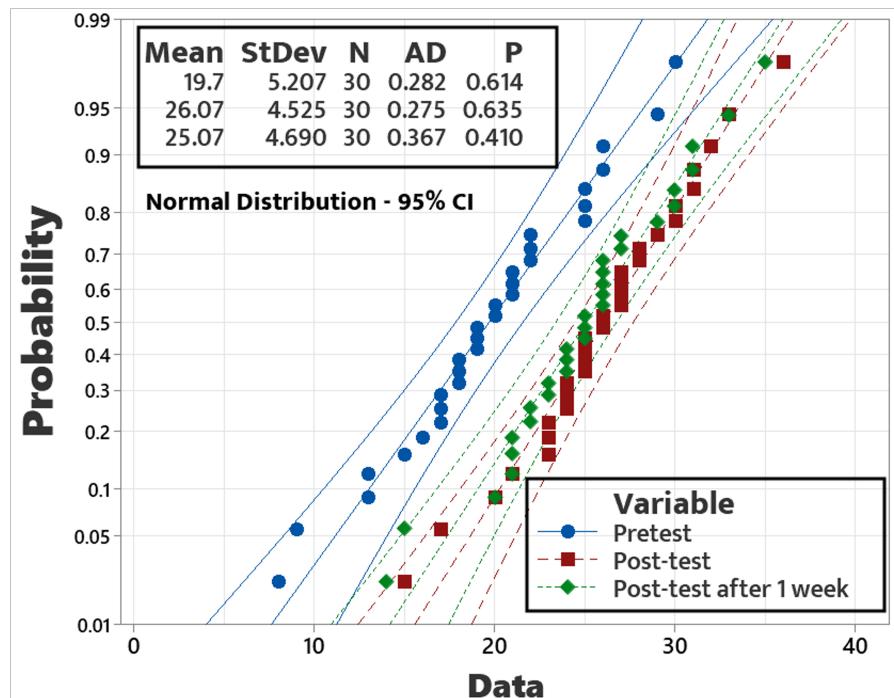


Figure E.3: Comparison of normality or Normal Distribution using Anderson Darling Test between Pre-test, Post-test, and Post-test (after one week) scores

Paired Samples Statistics					Paired Samples Correlations				
	Mean	N	Std. Deviation	Std. Error Mean		N	Correlation		
Pair 1	Post-test	26.0667	30	4.52528	.82620	30	.853		
	Pretest	19.7000	30	5.20709	.95068				
Pair 2	Post-test after 1 week	25.0667	30	4.68993	.85626	30	.968		
	Pretest	19.7000	30	5.20709	.95068				
Pair 3	Post-test after 1 week	25.0667	30	4.68993	.85626	30	.954		
	Post-test	26.0667	30	4.52528	.82620				

Paired Samples Test									
Paired Differences				95% Confidence Interval of the Difference					
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)	
Pair 1	Post-test - Pretest	6.36667	2.72262	.49708	5.35002	7.38331	12.808	29	.000
Pair 2	Post-test after 1 week - Pretest	5.36667	1.35146	.24674	4.86202	5.87131	21.750	29	.000
Pair 3	Post-test after 1 week - Post-test	-1.00000	1.41421	.25820	-1.52808	-.47192	-3.873	29	.001

Figure E.4: Results from Paired T-tests between Pre-test, Post-test, and Post-test (after one week) scores

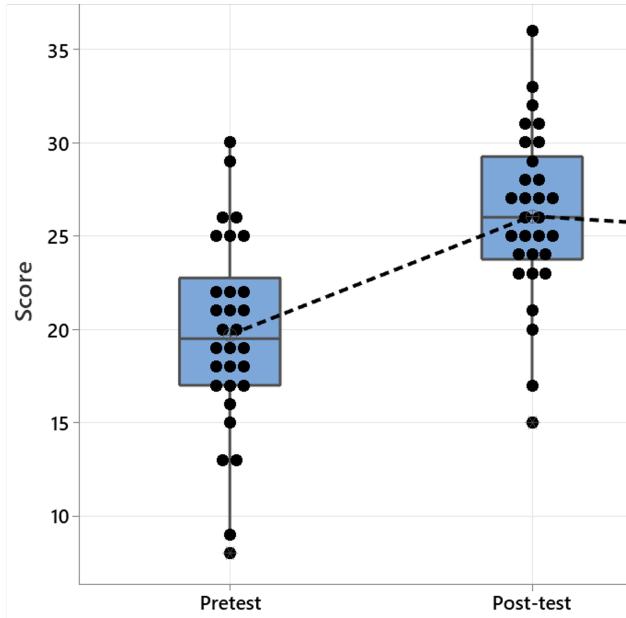
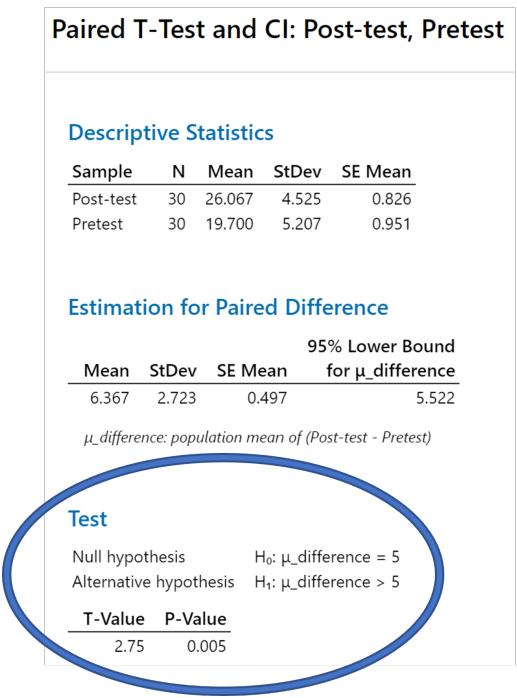


Figure E.5: Results from Paired T-tests between Pre-test, Post-test scores

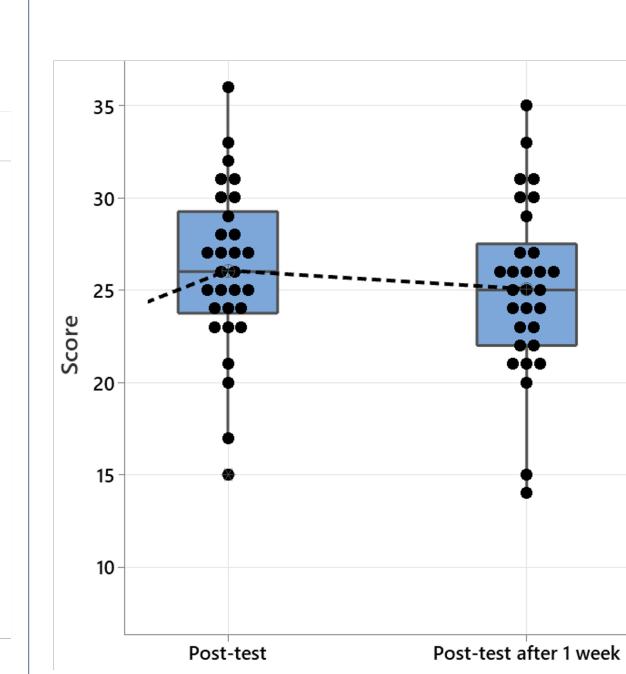
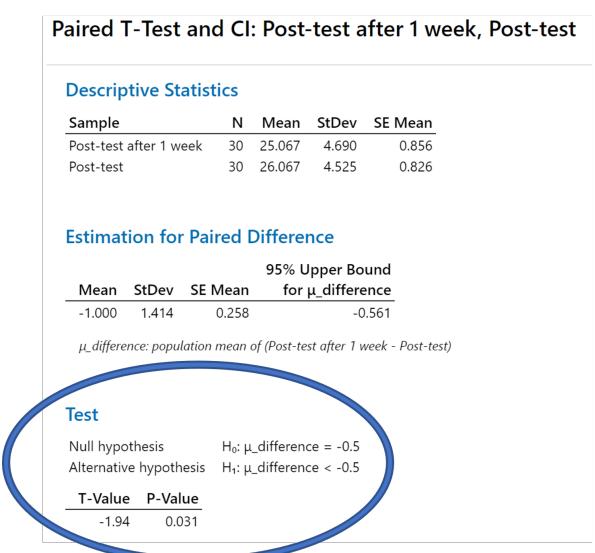


Figure E.6: Results from Paired T-tests between Post-test, and Post-test (after one week) scores

## Visualization of Scores of 3rd Yr Nursing Students

Pre and Post (n=35)

Card (n=25) and Digital (n=10)

● Card ● Digital

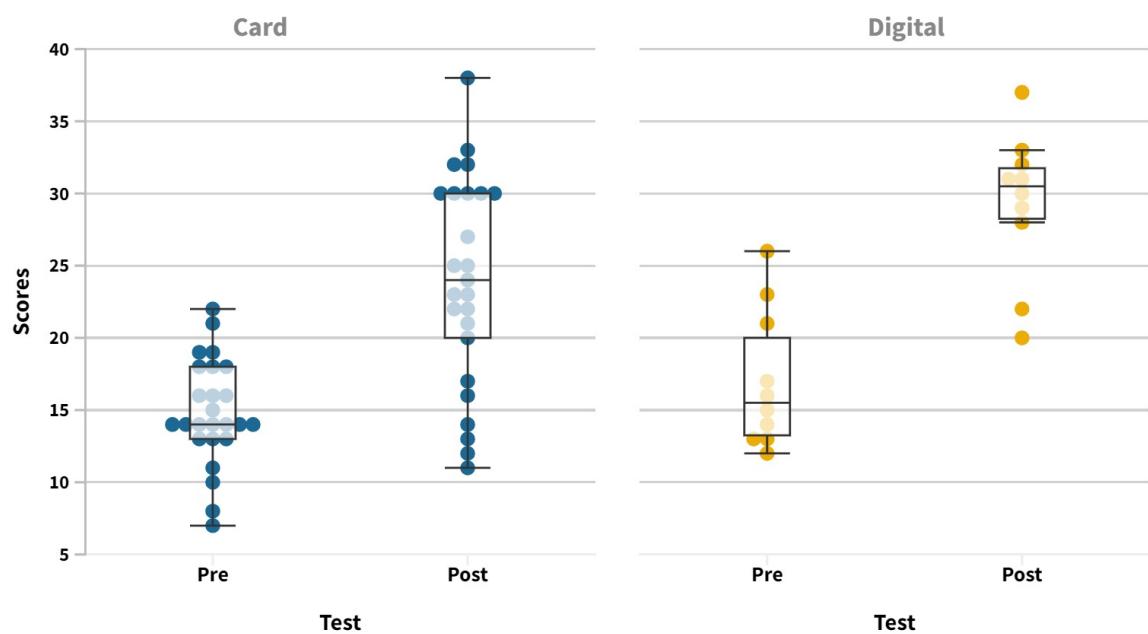


Figure E.7: Results from comparing the scores of nursing students

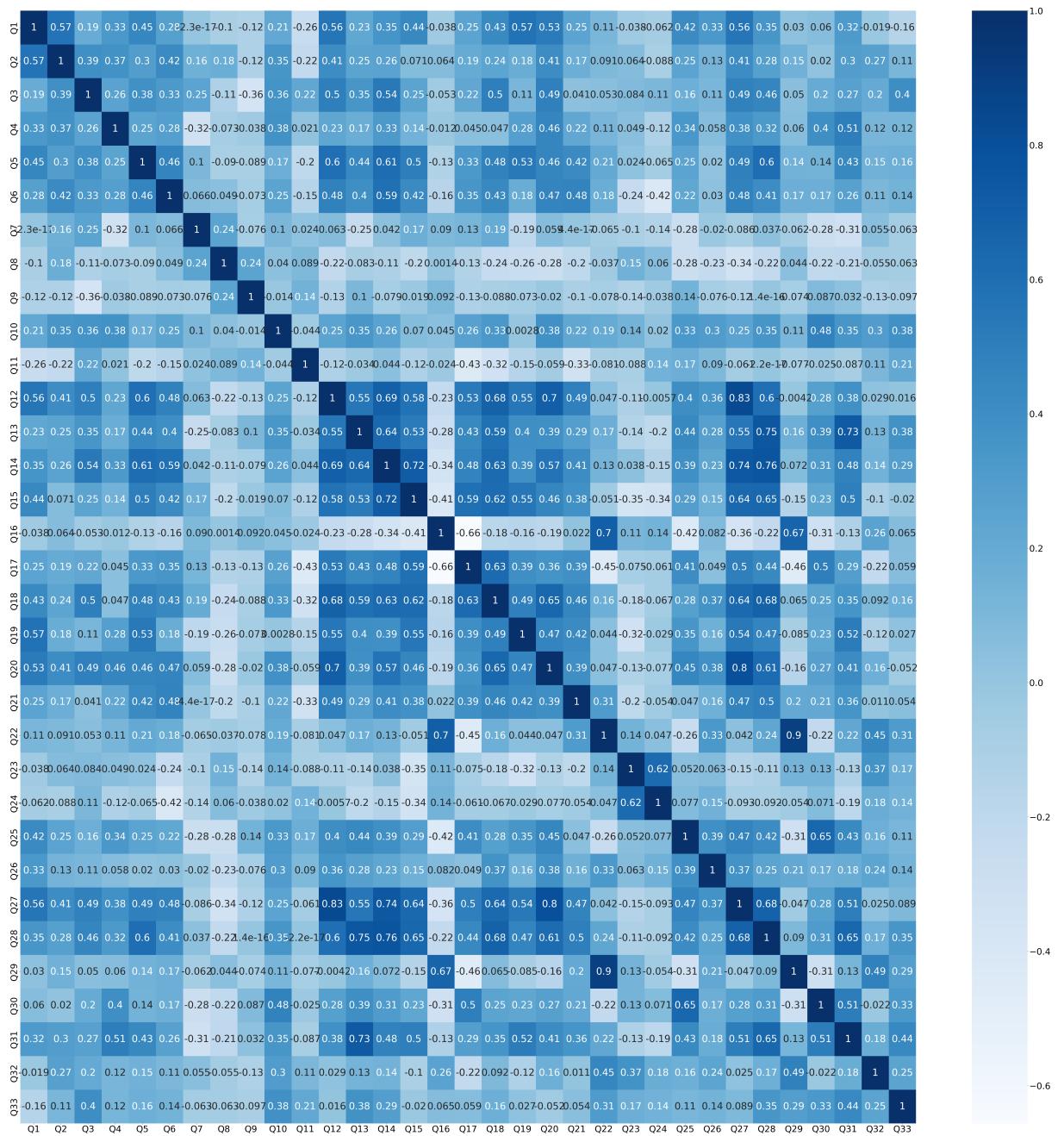


Figure E.8: Correlation matrix of GEQ of nursing students cohort

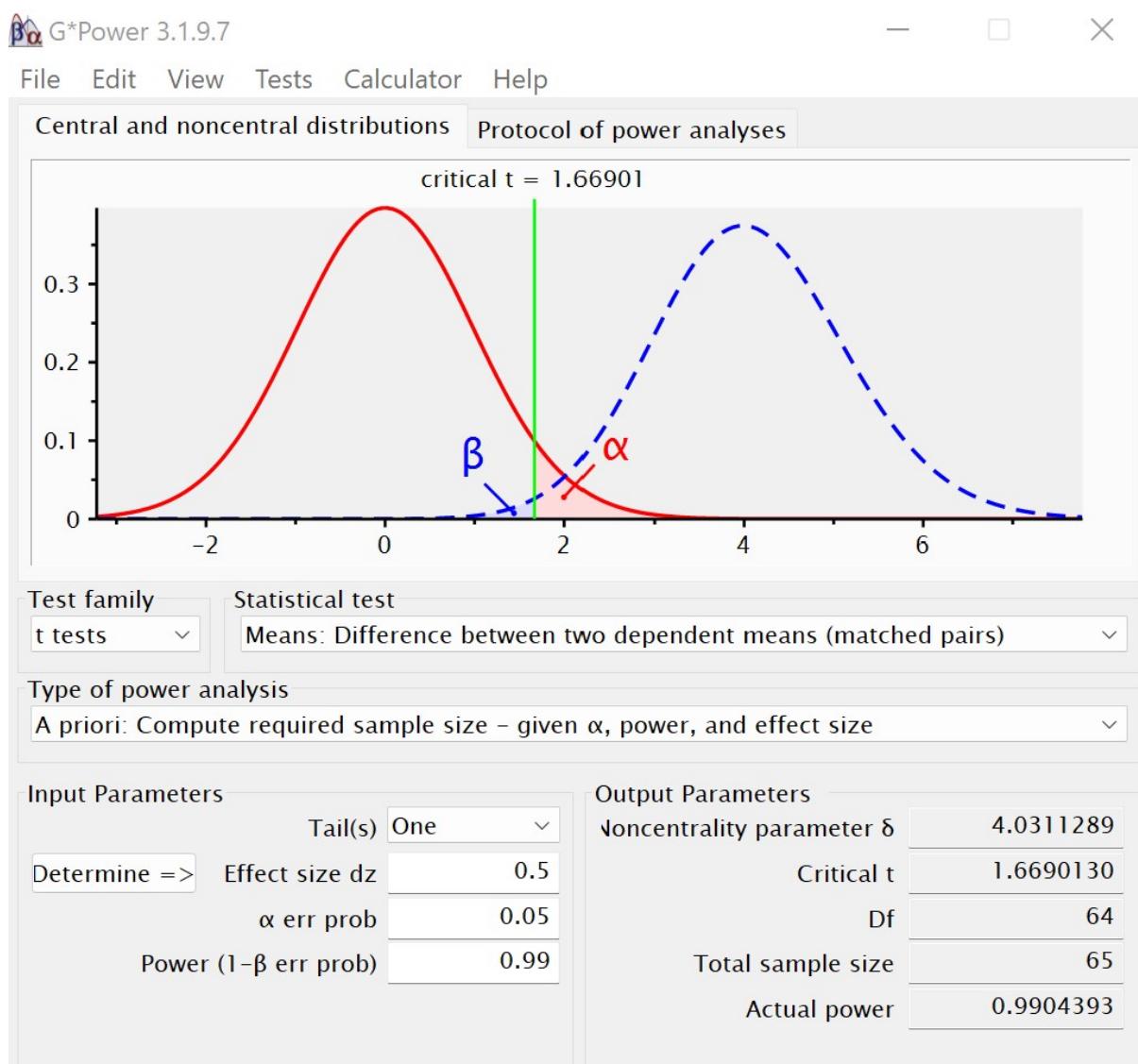


Figure E.9: Sample calculation for paired t-test, given alpha, power and effect size



## **Appendix F**

### **Field Images from Burhanpur**



Figure F.1: Baseline survey - Evaluation of prior-knowledge



Figure F.2: 4-ASHAs group playing with physical cards



Figure F.3: Focused Group Discussion after the ASHAs complete play-testing rounds



Figure F.4: A group photo with the ASHAs, the ASHA coordinator, the facilitator (Amit Kumar Ukey), and the researcher



## **Appendix G**

### **The designed deck of cards**

<b>1</b> कोलोस्ट्रम बच्चे का जन्म  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ	<b>1</b> के एम सी कंगारू मदर केयर बच्चे का जन्म  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ	<b>1</b> ओ पी वी - 0 ओरल ପୋଲିସି ଵୈକ୍ସିନ बच्चे का जन्म  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ	<b>1</b> हेपेटाईटिस बी बच्चे का जन्म  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ
<b>1</b> बी सी जी का टीका बैसिलस कैलमेट गुणरिन बच्चे का जन्म  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ	<b>2</b> ओ पी वी - 1 ओरल ପୋଲିସି ଵୈକ୍ସିନ <b>1½ महीने</b>  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ	<b>2</b> पेंटावैलेंट - 1 टीका <b>1½ महीने</b>  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ	<b>2</b> रोटा - 1 रोटावायरस का टीका <b>1½ महीने</b>  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ
<b>2</b> पी सी वी - 1 न्यूमोकोकल कंजुगेट टीका <b>1½ महीने</b>  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ	<b>2</b> आई पी वी - 1 इनएक्टिवेटेड ପୋଲିସି ଵୈକ୍ସିନ <b>1½ महीने</b>  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ	<b>3</b> ओ पी वी - 2 ओरल ପୋଲିସି ଵୈକ୍ସିନ <b>2½ महीने</b>  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ	<b>3</b> पेंटावैलेंट - 2 टीका <b>2½ महीने</b>  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ
<b>3</b> रोटा - 2 रोटावायरस का टीका <b>2½ महीने</b>  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ	<b>4</b> ओ पी वी - 3 ओरल ପୋଲିସି ଵୈକ୍ସିନ <b>3½ महीने</b>  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ	<b>4</b> पेंटावैलेंट - 3 टीका <b>3½ महीने</b>  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ	<b>4</b> रोटा - 3 रोटावायरस का टीका <b>3½ महीने</b>  NUTRITION GROUP IIT BOMBAY <b>ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ</b> ବ୍ୟାକ୍ ପୋଲିସି ଵୈକ୍ସିନ

Figure G.1: Immunization cards for children below 1 year (continued on next page)

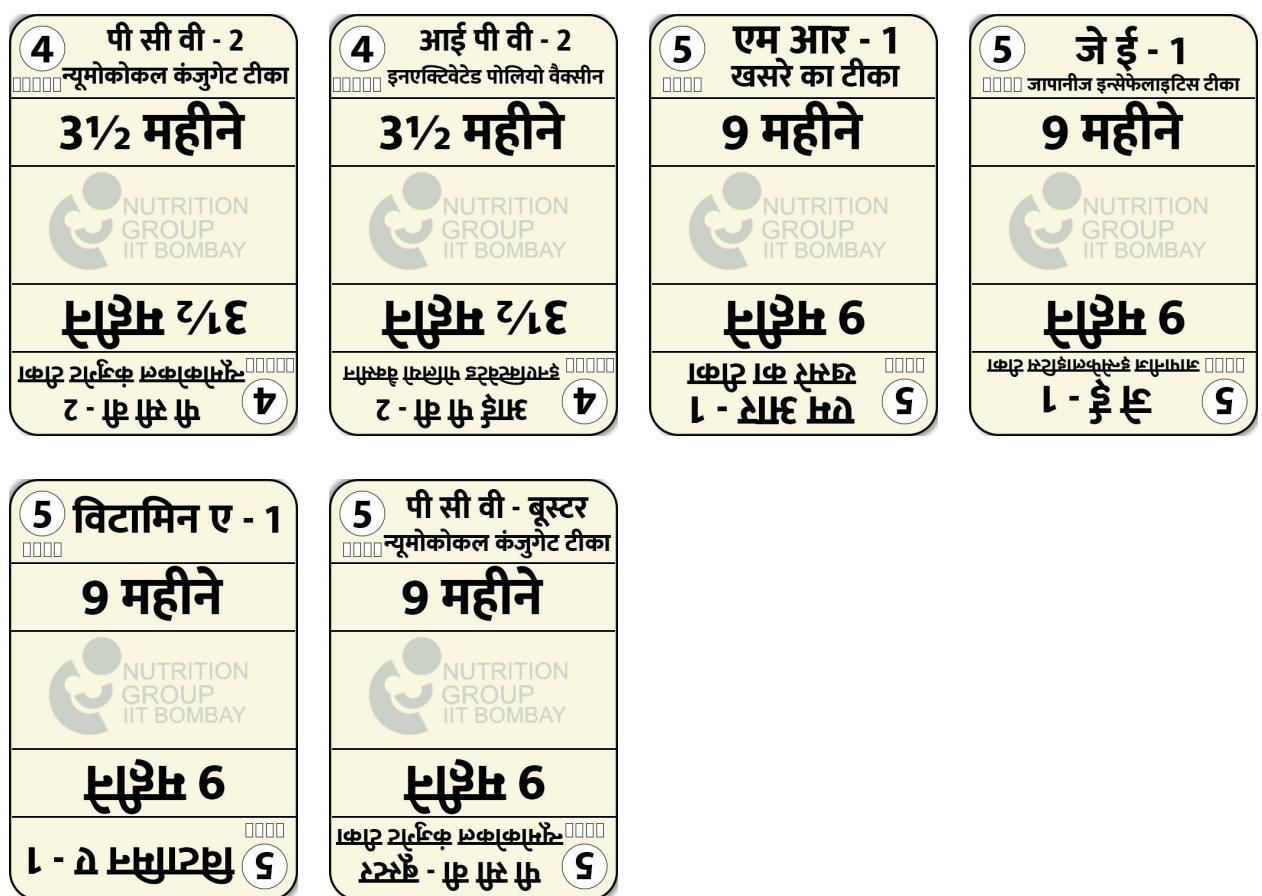


Figure G.2: Immunization cards for children below 1 year (continued from previous page)

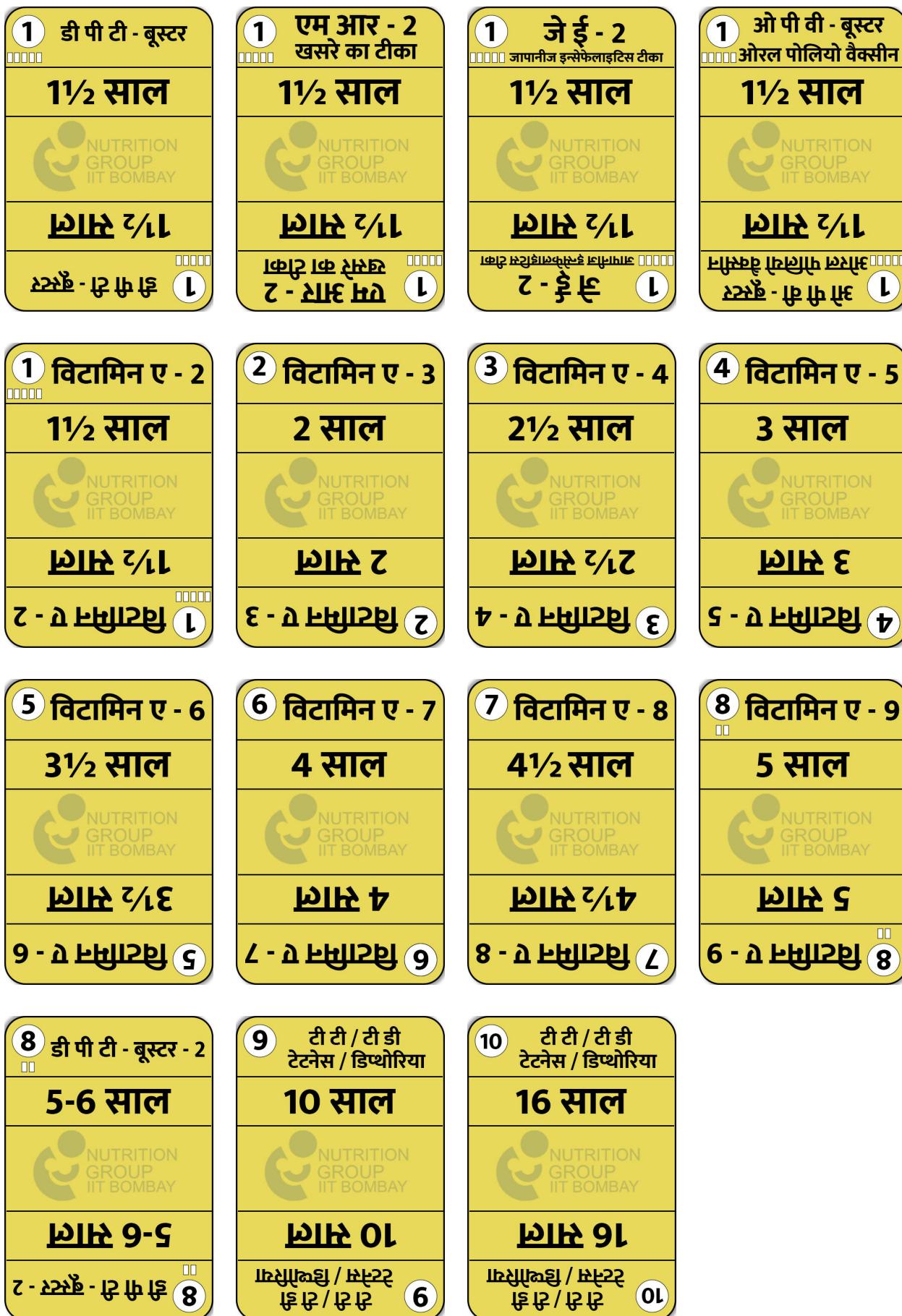


Figure G.3: Immunization cards for children above 1 year

<p><b>1</b> पिछले मासिक धर्म की अवधि</p> <p>NUTRITION GROUP IIT BOMBAY</p> <p>ପ୍ରାଣୀ ଶୁଦ୍ଧିତ ପାନୀ ପାଇଁ</p>	<p><b>2</b> मातृ एवं शिशु सुरक्षा (एम सी पी) कार्ड बनाएं</p> <p>NUTRITION GROUP IIT BOMBAY</p> <p>ପଂଜୀକରଣ</p>	<p><b>2</b> ଟୀ ଟୀ - 1 ଟିଟିଏସ ଟାଙ୍କସାଇଡ</p> <p>NUTRITION GROUP IIT BOMBAY</p> <p>ପଂଜୀକରଣ</p>	<p><b>3</b> ପ୍ରସବପୂର୍ବ ଦେଖଭାଲ - 1</p> <p>3 ମହୀନେ ଯା 12 ସପ୍ତାହକେ ଭୀତର</p> <p>NUTRITION GROUP IIT BOMBAY</p> <p>ପ୍ରାଣୀ ଶୁଦ୍ଧିତ ପାନୀ ପାଇଁ 1 ମହୀନେ</p>
<p><b>3</b> ସିଫଲିସ ପରୀକ୍ଷଣ ପ୍ରସବପୂର୍ବ ଦେଖଭାଲ - 1 କେ ଦୌରାନ</p> <p>NUTRITION GROUP IIT BOMBAY</p> <p>ପ୍ରାଣୀ ଶୁଦ୍ଧିତ ପାନୀ ପାଇଁ 1 ମହୀନେ</p>	<p><b>3</b> ଏଚ ଆଇ ଵି ପରୀକ୍ଷଣ ପ୍ରସବପୂର୍ବ ଦେଖଭାଲ - 1 କେ ଦୌରାନ</p> <p>NUTRITION GROUP IIT BOMBAY</p> <p>ପ୍ରାଣୀ ଶୁଦ୍ଧିତ ପାନୀ ପାଇଁ 1 ମହୀନେ</p>	<p><b>4</b> ଟୀ ଟୀ - 2 ଟିଟିଏସ ଟାଙ୍କସାଇଡ</p> <p>ଟୀ ଟୀ - 1 କେ 1 ମହୀନା ବାଦ</p> <p>NUTRITION GROUP IIT BOMBAY</p> <p>ପ୍ରାଣୀ ଶୁଦ୍ଧିତ ପାନୀ ପାଇଁ 1 ମହୀନେ</p>	<p><b>4</b> ଟୀ ଟୀ - ବୁସ୍ଟର ଟିଟିଏସ ଟାଙ୍କସାଇଡ</p> <p>ପିଛଲେ 3 ବର୍ଷ ମେ ଟୀଟୀ କେ 2 ଟୀକେ ଲଗଗା ଚୁକୀ ହେ</p> <p>NUTRITION GROUP IIT BOMBAY</p> <p>ପ୍ରାଣୀ ଶୁଦ୍ଧିତ ପାନୀ ପାଇଁ 2 ମହୀନେ</p>
<p><b>5</b> ପ୍ରସବପୂର୍ବ ଦେଖଭାଲ - 2 3-6½ ମହୀନେ ଯା 14-26 ସପ୍ତାହ</p> <p>NUTRITION GROUP IIT BOMBAY</p> <p>ପ୍ରାଣୀ ଶୁଦ୍ଧିତ ପାନୀ ପାଇଁ 3-6½ ମହୀନେ</p>	<p><b>5</b> ଆୟରନ ଫୋଲିକ ଏସିଡ (ଆଈ ଏଫ୍ ଏ) କୀ ଗୋଲିଆଁ 3 ମହୀନେ କେ ବାଦ</p> <p>NUTRITION GROUP IIT BOMBAY</p> <p>ପ୍ରାଣୀ ଶୁଦ୍ଧିତ ପାନୀ ପାଇଁ 3 ମହୀନେ</p>	<p><b>5</b> ଏଲ୍ବେଂଡାଜୋଲ କ୍ରମିନାଶକ ଗୋଲି 3 ମହୀନେ କେ ବାଦ</p> <p>NUTRITION GROUP IIT BOMBAY</p> <p>ପ୍ରାଣୀ ଶୁଦ୍ଧିତ ପାନୀ ପାଇଁ 3 ମହୀନେ</p>	<p><b>6</b> ଵିଟାମିନ ଡି ଯୁକ୍ତ କେଲିଶ୍ୟମ କୀ ଗୋଲିଆଁ 4 ମହୀନେ କେ ବାଦ</p> <p>NUTRITION GROUP IIT BOMBAY</p> <p>ପ୍ରାଣୀ ଶୁଦ୍ଧିତ ପାନୀ ପାଇଁ 4 ମହୀନେ</p>
<p><b>7</b> ପ୍ରସବପୂର୍ବ ଦେଖଭାଲ - 3 7 - 8½ ମହୀନେ ଯା 28 - 34 ସପ୍ତାହ</p> <p>NUTRITION GROUP IIT BOMBAY</p> <p>ପ୍ରାଣୀ ଶୁଦ୍ଧିତ ପାନୀ ପାଇଁ 7 - 8½ ମହୀନେ</p>	<p><b>8</b> ପ୍ରସବପୂର୍ବ ଦେଖଭାଲ - 4 9 ମହୀନେ ଯା 36 ସପ୍ତାହ</p> <p>NUTRITION GROUP IIT BOMBAY</p> <p>ପ୍ରାଣୀ ଶୁଦ୍ଧିତ ପାନୀ ପାଇଁ 9 ମହୀନେ</p>		

Figure G.4: Ante-Natal-Care (ANC)



Figure G.5: Post-Natal-Care (PNC)

## **Appendix H**

### **Mobile app Screenshots**

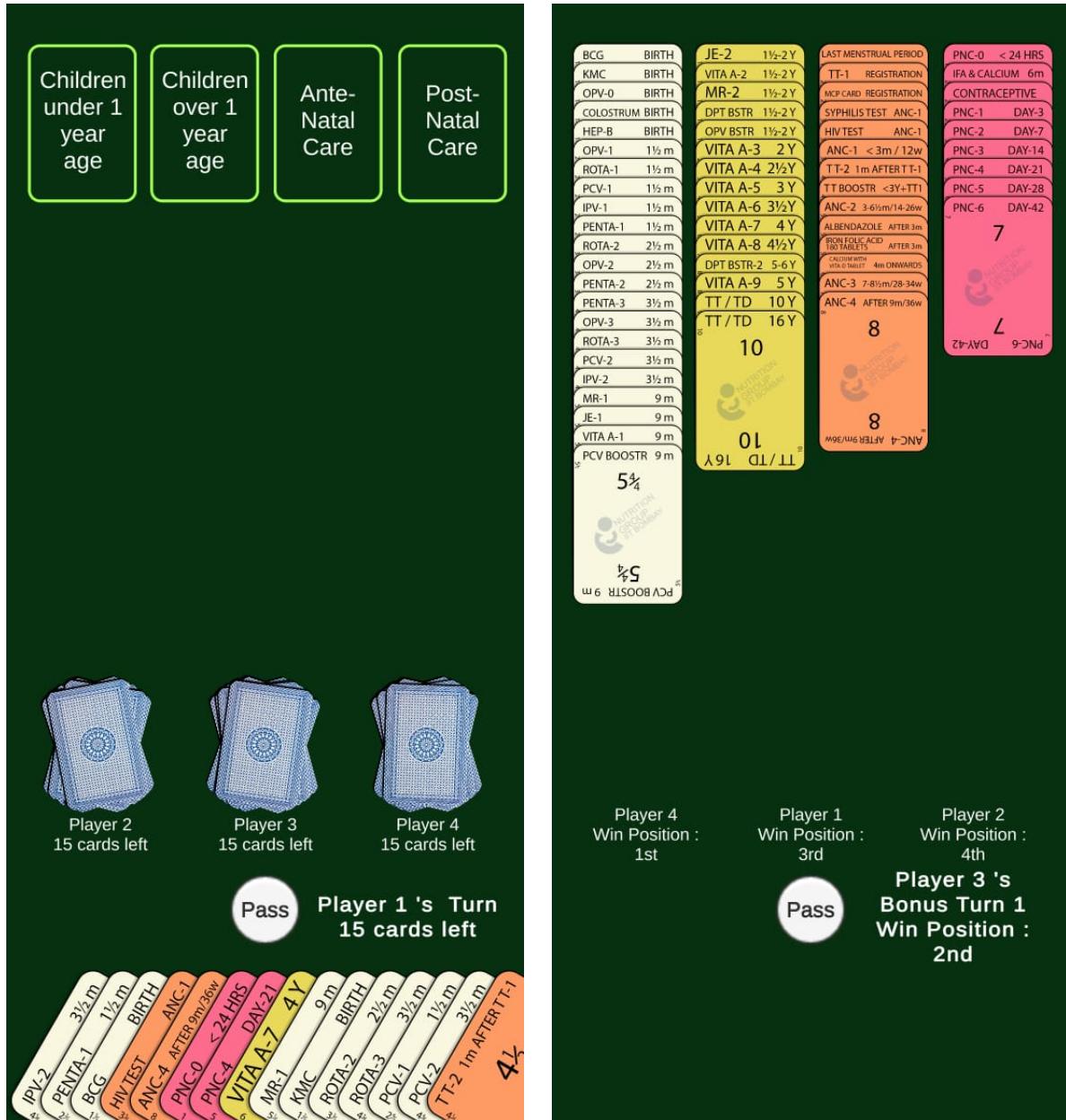


Figure H.1: Mobile app Screenshot - Play Start and End Screen (4 players playing with one phone and passing after their turn)

## **Appendix I**

### **Institute Review Board Approval**



IRCC, Office of the Dean R&D, IIT Bombay

INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

**Institutional Review Board (IRB)**

January 17, 2023

To  
Prof. Satish Agnihotri  
CTARA  
IIT Bombay

**Ref: Proposal No. IITB-IRB/2022/051**

**Sub: Review of the above-mentioned project proposal**

Dear Professor,

Thank you for submitting your proposal to the IITB Institutional Review Board (IRB) for review. The IRB has reviewed the proposal submitted by you and the following proposal is approved:

Proposal number : **IITB-IRB/2022/051**  
Title : **Refresher Training through Games for Frontline Healthcare Workers on Maternal and Newborn care**

The IRB approval is for the ethical conduct of the study. The study is approved for the entire duration and a closure report should be submitted within 2 months of the completion of the study.

Further, it is also confirmed that neither you, nor any of the study team members have participated in the decision-making process of the committee.

In case there are any changes in the proposed work (which is not limited to scope, dates, participants and methodology etc.), please communicate to IRB within 15 days of such a change.

Thank you.  
With Best wishes from IRB for your study,

D Parthasarathy  
Chairperson IITB-IRB

Figure I.1: IRB Approval

# References

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# List of Publications

## International Conferences

1. **Majhi, A.**, Mondal, A., Joshi, A., Agnihotri, S. B., 2021. Refresher Training through Quiz App for capacity building of Community Healthcare Workers or Anganwadi Workers in India. ”, *CHI 2021 : Asian CHI Symposium 2021, Virtual, Yokohama, Japan, May 2021*, ACM International Conference Proceeding Series.  
<https://dl.acm.org/doi/10.1145/3429360.3468186>  
(Best Paper award in Long Paper category)
  
2. **Majhi, A.**, Agnihotri, S. B., Mondal, A., 2021. Physical and Augmented Reality based Playful Activities for Refresher Training of ASHA Workers in India ”, *CHI 2022 : Asian CHI Symposium 2022, Virtual, New Orleans, LA, April 2022*, ACM International Conference Proceeding Series.  
<https://dl.acm.org/doi/10.1145/3516492.3558788>  
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