Replay, Revise, and Refresh: Smartphone-Based Refresher Training for Community Healthcare Workers in India

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Abstract. In India, community healthcare workers are the primary touchpoints between the state and the beneficiaries, such as pregnant mothers and children. Their healthcare knowledge directly impacts the quality of care they provide through home visits and community activities. Classroom in-person or traditional ways of training are found ineffective in imparting knowledge and render poor knowledge retention, which needs reinforcements through short, frequent revisions. Smartphone games on healthcare topics could be a promising solution as a refresher, as they can be scaled and tailored as per players' requirements. This study aims to check the differences in knowledge gain, pre and post-intervention, and, secondly, to check knowledge retention after six months. 270 CHWs or participants were recruited to evaluate different modes of refresher training and assigned into three equal groups of 90 each. The control group (CG) ($n = 90$) was trained using the standard classroom method, which is usually followed. Intervention Group-1 (IG1) ($n = 90$) was trained in a physical card game format, and Intervention Group-2 (IG2)($n = 90$) was trained in a smartphone game format. 4 sets of questionnaires were made by shuffling 45 questions based on immunization of equal weightage. The questionnaires were filled out by CHWs by hand and collected, evaluated, and analyzed. Paired t-tests were conducted to compare pre-post knowledge increments and repeated measure ANOVA to check for differences in knowledge retention. Results suggest a significant difference in scores in all three groups. A significant difference was observed between the physical and digital gameplay modes. Pre-post knowledge increment was higher in the digital mode ($p < 0.05$), but knowledge retained was not significantly different ($p = .4$) in digital and physical card versions. Card games confirm their effectiveness in gaining knowledge when compared to classroom training. Through this research, we found that the gamified way of learning has an improved retention rate compared to the traditional training method.

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1 Introduction

There are two main cadres of community healthcare workers (CHWs) with overlapping and sometimes complimentary job roles: Accredited Social Health Activists (ASHAs) and Anganwadi Workers (AWWs). The ASHAs bridge the gap between citizens and government by facilitating access to healtWhile services and receiving performance-based incentives [4]. While the AWWs handle mother and child nutrition, early education, and overall development. They are forced to work in challenging conditions, with incomplete information, low compensation, and unrecognized or invisible efforts [25]. Their caregiving nature is motivated not only by their salary or incentive but also by the desire to earn respect, familiarity, and trust from the community [25]. Evaluation-based research highlights inadequate training and supervision as the primary challenges to the performance of CHWs [3,6].

According to the National Family Health Survey-5 (NFHS-5; 2019-20) [11], immunization coverage for children aged 12–23 is 62.2%, a marginal improvement from the last round, NFHS-4 60% [10], despite efforts from the government to provide free vaccinations through Universal Immunization Program (UIP) and mission Indradhanush. The Mother and Child Protection Card (MCPC) is given to pregnant women when they first register for pregnancy. It contains the child's immunization schedule and the necessary information for mothers. The CHWs' lack of sound knowledge of immunization, service schedules, and related information on MCPC reduces the effectiveness of their services [1,2]. Partial understanding of immunization schedules by CHWs often leads to partial child immunization in the community [14]. Hence, it becomes trivial for CHWs to understand the immunization schedule. Therefore, we chose the timeline or content of the child immunization schedule, which is derived from the Indian Academics of Paediatrician (IAP) guidelines [13] (referred in Table 1), Ante-Natal Care (ANC) or during pregnancy and Post-Natal Care (PNC) or after the birth of a baby, as the learning material.

Classroom in-person or traditional ways of training are found ineffective in imparting knowledge and render poor knowledge retention, which needs reinforcements through short, frequent revisions. The adoption of smartphones in India [23] is fast increasing. Smartphones are being given to the CHWs to maintain records of mothers and children. Smartphone-based games on healthcare topics could be a promising solution as a refresher training for the CHWs. Digital or smartphone-based games engage players through gameful interactions, are customizable according to the player's learning requirements, are playable by low-literate and less tech-savvy players, and reach a large audience by listing in app stores.

The study tries to answer the following research questions:

- **RQ1:** Are games an effective alternative to in-person, traditional classroom refresher training?
- **RQ2:** Do physical and digital gameplay modes differ significantly in knowledge gains?
- **RQ3:** Do physical and digital gameplay modes differ significantly in long-term (after three weeks) knowledge retention?

Table 1. Child Immunization schedule

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		✓		✓		
Pentavalent		✓	✓	✓		
PCV		✓		✓	✓	
Rota		✓	✓	✓		
MR					✓	✓
JE					✓	✓
DPT						✓

1.1 Related Works

Previous researchers conducted different methods of training CHWs. A group of researchers suggested using community radio to broadcast training materials to the masses [15–17,26,28–30]. Researchers created and collected short informative videos on community healthcare and distributed them to CHWs through memory cards for mobile phones for offline viewing [12,21]. After watching the short videos, researchers conducted quizzes through phone calls [22] and quiz apps on their smartphones [19] to refresh their knowledge, followed by an incentive of talk time in the form of cell phone balance. Instructional illustrations were also tried to impart procedural knowledge to the CHWs [24]. Playful activities based on Augmented Reality were tested for collaborative play and refresher training on immunization [18].

2 Methodology

2.1 Physical and Digital Card Game

A deck of 60 cards is designed to represent all the vaccines and services related to mother and child care. The cards are divided into four silos or foundations:

Children below one year, Children above one year, Antenatal care and Postnatal care. The game aims to sequence the cards as per their schedule. Each player takes turns putting their card from hand to the foundations, towards completing the sequence forward or backward, starting from a point in each of the four foundations. The player emptying their hand first wins the game. A digital version of the game with the same rules was designed to compare the effectiveness of both modalities through user testing. The details of the game are not in the scope of this paper.

Fig. 1. Physical card Decks

2.2 Participants

The sample size was calculated using G-Power [5]. T-test with independent means was chosen as the statistical test ($d = 0.5$, $1 - \beta = 0.95$, and $\alpha = 0.05$). The required sample or number of participants for each group was calculated to be 88. Considering attrition, 95 were recruited for each group. However, post-attrition, 90 participants from each group were retained till the end of the study, totaling 270 participants across three groups.

2.3 Ethical Consideration

The Institute Review Board, Indian Institute of Technology Bombay, India [9], approved the ethical conduct of the study (Approval No: IITB-IRB/2022/051),

Table 2. A. Participants' Demography and B. & C. Study Results

A. Participants' Demography						
	Intervention Group-1 Digital Card Game (n = 90)		**Intervention Group-2 Physical Card Game** (n = 90)		**Intervention Group-3 Classroom In-Person training** (n = 90)	
Parameters	ASHAs(%) (n = 45)	AWWs(%) (n = 45)	ASHAs(%) (n = 45)	AWWs(%) (n = 45)	ASHAs(%) (n = 45)	AWWs(%) (n = 45)
Age group (years)						
Less than 30	1 (2.22%)	0 (0%)	1 (2.22%)	1 (2.22%)	2 (4.44%)	2 (4.44%)
30–40	22 (48.89%)	19 (42.22%)	22 (48.89%)	20 (44.44%)	23 (51.11%)	19 (42.22%)
40–50	21 (46.67%)	25 (55.56%)	20 (44.44%)	24 (53.33%)	20 (44.44%)	24 (53.33%)
No information	1 (2.22%)	1 (2.22%)	2 (4.44%)	0 (0%)	0 (0%)	0 (0%)
Education (schooling grade)						
Below 8^{th}	3 (6.67%)	2 (4.44%)	1 (2.27%)	2 (4.44%)	1 (2.22%)	2 (4.44%)
8^{th}–10^{th}	9 (20%)	11 (24.44%)	9 (20.45%)	14 (31.11%)	10 (22.22%)	12 (26.67%)
10^{th}–12^{th}	29 (64.44%)	28 (62.22%)	29 (65.91%)	23 (51.11%)	29 (64.44%)	27 (60%)
Graduate and above	4 (8.89%)	4 (8.89%)	4 (9.09%)	5 (11.11%)	5 (11.11%)	4 (8.89%)
No information	0 (0%)	0 (0%)	1 (2.27%)	1 (2.22%)	0 (0%)	0 (0%)
Experience as CHWs (years)						
0–5	2 (4.44%)	2 (4.44%)	4 (8.89%)	3 (6.67%)	4 (8.89%)	2 (4.35%)
5–10	18 (40%)	17 (37.78%)	16 (35.56%)	16 (35.56%)	19 (42.22%)	17 (36.96%)
10–15	18 (40%)	18 (40%)	18 (40%)	19 (42.22%)	17 (37.78%)	18 (39.13%)
Above 15	7 (15.56%)	8 (17.78%)	7 (15.56%)	6 (13.33%)	4 (8.89%)	8 (17.39%)
No information	0 (0%)	0 (0%)	0 (0%)	1 (2.22%)	1 (2.22%)	1 (2.17%)
Experimental Study Results	**Intervention Group-1 Test Scores**		**Intervention Group-2 Test Scores**		**Intervention Group-3 Test Scores**	
Test phase	Mean (SD)	Median (min-max)	Mean (SD)	Median (min-max)	Mean (SD)	Median (min-max)
Pre-test scores	24.85 (3.34)	24.16 (18–33)	24.28 (2.88)	24.13 (19–30)	25.02 (3.19)	24.69 (19–32)
Post-test scores	35.62 (3.57)	35.56 (28–42)	31.86 (4.1)	31.48 (24–42)	30.01 (4.32)	29.71 (19–39)
Long Post-test scores (After three weeks)	31.75 (4.69)	32.23 (22–41)	30.62 (4.1)	30.82 (21–40)	26.46 (3.54)	26.75 (19–34)
B. Between-group comparisons of total scores according to the three points of assessment						
	Pre-test		**Post-test**		**Long-term Post-test**	
IG-1 × IG-2 × IG-3	$F_{2,45} = 0.84, p = .44$		$F_{2,45} = 22.96, p < .00001$		$F_{2,45} = 20.62, p < .00001$	
C. Within-group comparisons of total scores according to the three points of assessment						
Paired t-test results Points of Assessment	**Intervention Group-1** (p-value)		**Intervention Group-2** (p-value)		**Intervention Group-3** (p-value)	
Pre-test × Post-test	0		0		1×10^{-7}	
Pre-test × Long-term Post-test	2×10^{-10}		0		0.04	
Post-test × Long-term Post-test	6×10^{-5}		0.12 (Not Significant at $p < .05$)		6×10^{-5}	
D. Between-group comparisons of total scores according to the three points of assessment						
Paired t-test results (All groups combined) Point of Assessment			**Intervention Group-1** (p-value)			
Pre-test × Post-test			0			
Pre-test × Long-term Post-test			2×10^{-20}			
Post-test × Long-term Post-test			7×10^{-7}			

which adheres to the guidelines of the Declaration of Helsinki [27]. All participants were verbally informed about the objective and procedure of the study. Written consent with a signature was obtained every time a survey was conducted with the participants and included in the questionnaire. The results of the surveys and study findings were provided to the CHW supervisors so that they could understand the overall knowledge gained and retention of the CHWs. However, the names and other identifiers of the participants were masked.

2.4 Evaluation

The knowledge of CHWs is assessed through questionnaire surveys in three points. Initially, a baseline survey is conducted to check the prior knowledge. Then, as per the allotted groups, they either get a deck of cards or install the app on their phones. Then, the CHWs either play the card game on their smartphones (IG1) or the physical card game (IG2) or attend regular in-person classroom training (IG3). Then, another assessment is conducted to check the immediate knowledge gained after the refresher training. Then, CHWs are encouraged to play and attend classes according to their allotted groups for the next three weeks. Previous researchers suggest two or more weeks for retention tests [8,20]. After that, a long-term post-test survey is conducted to check the knowledge retention of the CHWs.

The questionnaire starts with consent to participate in the evaluation study by filling in demographic details and putting in a signature. It contains 45 multiple-choice, single-correct questions of equal weightage and is shuffled for each assessment point. CHWs are usually given 30 min to fill out the questionnaire. Researchers and volunteers check the answers against a solved questionnaire and calculate the score for each participant. They are then analyzed to check for trends in knowledge gain and retention.

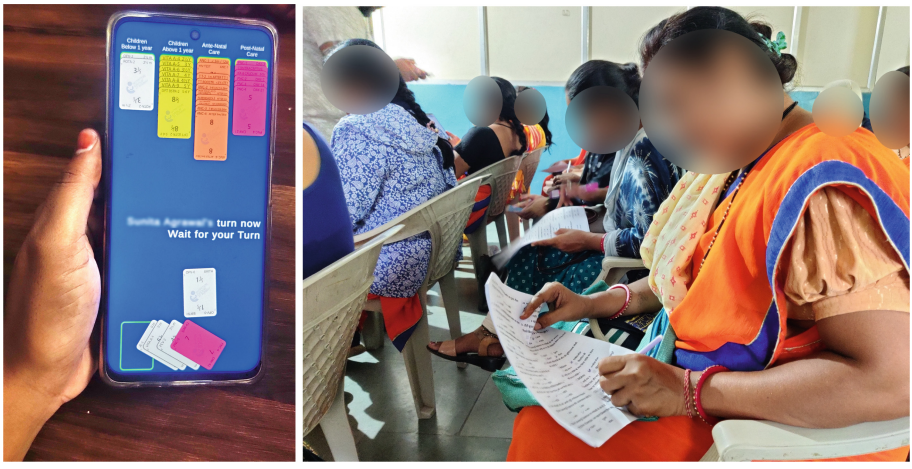

Fig. 2. Left: Photo of CHW holding her smartphone during gameplay session; Right: CHWs filling questionnaire survey form

All group scores were checked for normality before conducting parametric tests. Paired t-tests were conducted within groups and between groups. Repeated Measure ANOVA and multiple One-Way ANOVA were performed to check if there was an overall difference in scores within groups and between groups and with points of assessment.

3 Findings

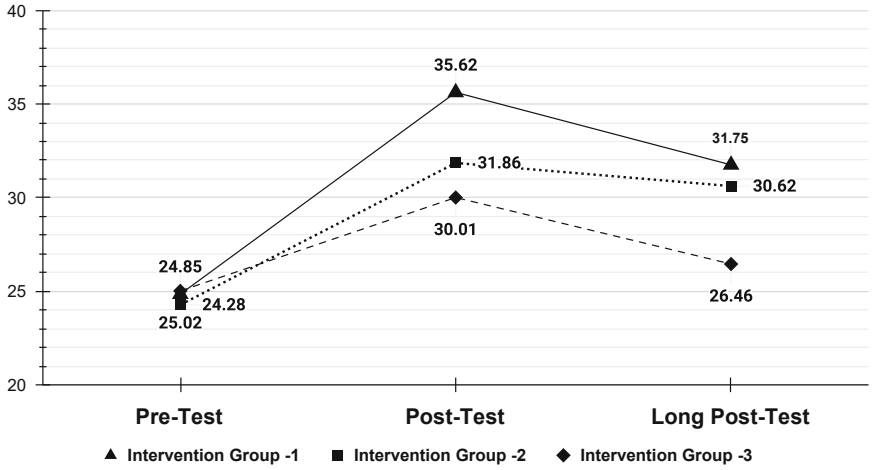

Fig. 3. Line chart showing trends of change of mean value in the pre-test, post-test, and long post-test

Between Group (Table 2 B):

Pre-test scores: No significant differences were found between groups ($F = 0.84, p = .44$) at $p < .05$. We found that the baseline or prior knowledge was not significantly different across the three groups.

Post-test scores: Significant differences were found between groups ($F = 22.96, p < .00001$) at $p < .05$. Tukey's HSD test shows pairwise significant difference ($Q_{.05} = 3.35$) between IG1 and IG2 ($Q = 6.36$ ($p = .00004$)) & IG3 ($Q = 9.39$ ($p < .000001$)) and no significance between IG2 and IG3 ($Q = 3.03$ ($p = .085$)). IG1, or smartphone app intervention group, scored exceptionally better than IG2, or physical card game, and IG3, or in-person training.

Long-term Post-test scores: Significant difference between groups ($F = 20.62, p < .00001$) at $p < .05$. Tukey's HSD test shows pairwise significant difference ($Q_{.05} = 3.35$) between IG3 and IG1 ($Q = 8.62$ ($p < .000001$)) & IG2 ($Q = 6.78$ ($p = .00001$)) and no significance between IG1 and IG2 ($Q = 1.84$ ($p = .4$)).

Within Group (Table 2 C): A significant difference was observed between all three groups across all assessment points except IG2 while comparing post-test and long-term post-test ($p = .12$, $p > .05$)

Between Group (Table 2 D): Pre-test scores were significantly lower compared to post-tests and long-term post-tests. A significant difference was

observed between all three groups across all assessment points. A decline in knowledge retention across the groups confirms the pattern of depleting knowledge over time. Comparing digital and physical card game outcomes, it's interesting to note that the immediate knowledge gained post-intervention in smartphone mode or digital one (IG1) is significantly higher compared to physical card play mode (IG2). However, the long-term post-test scores showed lower knowledge retention in all three groups. IG2 had the highest retention rate, and the loss of knowledge was minimal compared to the baseline or pretest scores. After three weeks, the retained knowledge or long-term post-test scores were similar or not significantly different between digital and physical play modes or IG1 and IG2. The knowledge graph of the three groups (Fig. 3) also reflects the findings.

4 Discussion

In this study, we compared two modes of refresher training for CHWs: traditional in-person refresher training and training through games (RQ1). Also, we compared if there is a difference in knowledge acquisition between physical and digital card play (RQ2). Also, we compared if there is a difference in knowledge retention between physical and digital card play (RQ3). The study evaluates the efficacy of three refresher training methods. It provides objective evidence to curriculum designers and decision-makers on implementing the method and the expected short- and long-term deployment outcome.

After the study, we interviewed some CHWs for feedback. Some CHWs expressed their preference for printed study materials over the phone app. They said that the printed materials improve their knowledge and act as a vetted brochure to show to mothers during counseling sessions or home visits. Some said the printed brochure lets them relax and study independently, at their own pace. Some reported distractions when playing smartphone games for refresher training compared to reading class notes or printed brochures.

5 Limitations

This is a field-based study and was conducted in government institutions like government hospitals and training centres. Some CHWs might feel intimidated by their supervisor's presence while giving feedback on the play experience. Often, one smartphone was shared by multiple CHWs. Some felt uncomfortable using someone else's devices due to the possessiveness and affordances that users grow using their own devices. Conducting a true experiment is impossible in this case because it does not fulfill the condition of a true experiment [7]. So, we conducted a quasi-experimental study. The drawback of such a study lies in lower internal and higher external validity, as the effectiveness is judged through the outcome [7].

6 Novelty

As far as we know, this research attempted to explore the effects of combining two CHW cadres, ASHAs and AWWs, as a team to play physical and digital card games for their refresher training for the first time.

7 Conclusion

The study results show that the digital play mode enhanced knowledge better than the physical mode. However, the digital mode has shown a marginal improvement in long-term knowledge retention compared to the physical mode. The latter finding is more important, as knowing the long-term effects of an intervention is required for curriculum development, implementation, policy recommendations, and future decision-making. It is important to note that the gamified training method is not intended to replace the initial in-person training of the CHWs but to act as a voluntary refresher training for the CHWs to help them revise the child immunization schedule and other services.

7.1 Future Works

Further studies need to be conducted, considering other variables that might affect the intrinsic and extrinsic motivation of playing the game. Longitudinal studies need to be undertaken to check improved learning outcomes, with more arms for checking variations in learning effectiveness and a larger sample size for a more balanced and better representation of CHWs in India.

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