Designing Digital Games for Rural Children: A Study of Traditional Village Games in India

Matthew Kam[*]**, Akhil Mathur**[#]**, Anuj Kumar**[#] **and John Canny**[†]
[*]Human-Computer Interaction Institute, Carnegie Mellon University, USA
[#]Dhirubhai Ambani Institute of Information and Communication Technology, Gujarat, India
[†]Computer Science Division and Berkeley Institute of Design, University of California, Berkeley, USA
mattkam@cs.cmu.edu

ABSTRACT

Low educational levels hinder economic empowerment in developing countries. We make the case that educational games can impact children in the developing world. We report on exploratory studies with three communities in North and South India to show some problems with digital games that fail to match rural children's understanding of games, to highlight that there is much for us to learn about designing games that are culturally meaningful to them. We describe 28 traditional village games that they play, based on our contextual interviews. We analyze the mechanics in these games and compare these mechanics against existing videogames to show what makes traditional games unique. Our analysis has helped us to interpret the playability issues that we observed in our exploratory studies, and informed the design of a new videogame that rural children found to be more intuitive and engaging.

Author Keywords
Developing world, digital divide, games, traditional games

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Poor literacy and low educational levels remain barriers to economic empowerment in the developing world. On the other hand, educational games can make a profound impact on the learning needs of underserved communities. At least two non-government organizations, Pratham and the Azim Premji Foundation, have deployed computer games in their initiatives with children living in the urban slums and rural areas of India respectively. Most importantly, a large-scale evaluation by Pratham[1] demonstrated significant gains on mathematics test scores from playing computer games that target mathematics learning [4]. Early experiments by the Azim Premji Foundation [2] and Kam et al. [15] with rural children in India have shown equally promising outcomes with e-learning games for English as a Second Language (ESL) and other subjects.

Videogames can be designed such that they employ good educational principles, and hence promote learning benefits [10]. Games have immersive properties, such that the player experiences himself as being "inside" the game. Games recreate virtual environments with rich backgrounds where players participate actively. Games continually challenge players to develop new skills and reward the acquisition of these skills, especially when they spend hours playing the games. Finally, games can be social experiences that create a shared context for social communication.

A recent article reports on the phenomenal sales of mobile games in India, and adds that although mobile games there are currently targeted at urban consumers, "the real market … lies in rural areas" [7]. This phenomenon is part of the broader trend in which the cellphone is the fastest growing technology platform in the developing world. At the same time, public schools in developing regions face numerous difficulties. From the literature [3] and our fieldwork in the poorest state of India, for example, one significant factor stands out: non-regular school attendance owing to the need for children to work for the family in agricultural fields or homes. Hence, e-learning games on cellphones and other inexpensive mobile devices can make educational resources more accessible to rural children in out-of-school settings, at places and times that are more convenient than school.

However, in a study by Kam et al. where 8 existing mobile games were tested with rural children in India, users did not necessarily find the games intuitive, exciting or free from playability problems [14]. It seems that rural children have

---

[1] A longitudinal randomized experiment over more than two years with over 10,000 urban slums students.
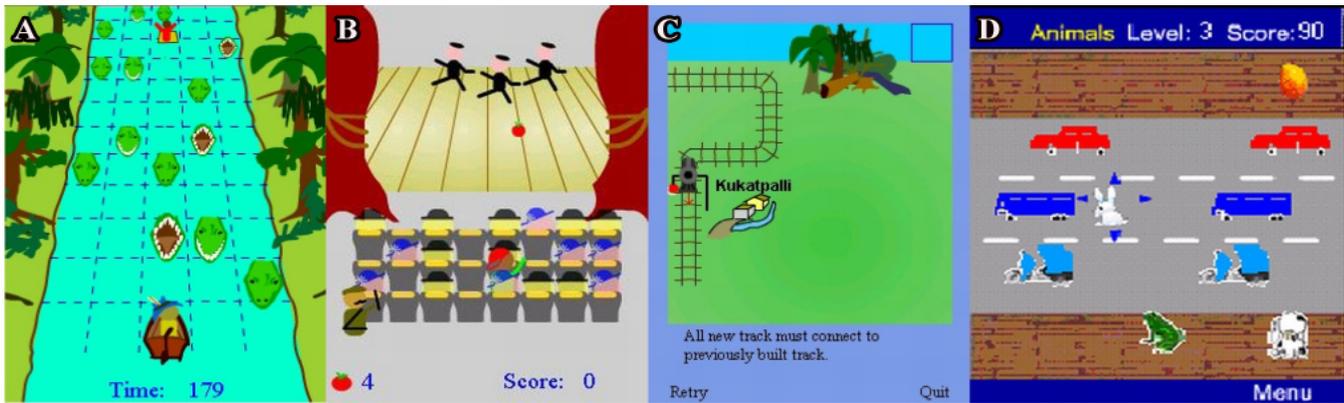
Figure 1. The games that we designed for rural children in India: (A) Crocodile Rescue, (B) Dancer, (C) Train Tracks and (D) Frogger. We tested these games in exploratory studies with three communities to understand the extent to which our qualitative observations on how well rural children engage with their design features repeat – or fail to – across communities.

relatively little exposure to videogames, which have been influenced by Western traditions. Existing videogames thus arguably fail to match the understandings or expectations that rural children have about games. On the other hand, rural children are more familiar with the traditional games that they play in their villages. It is timely to study the latter games so that we can address these questions: what can we learn from traditional games so that we can design digital games that rural children can relate to more readily? What are some of the game mechanics in traditional games? How do village games differ from contemporary videogames?

In the rest of this paper, we first summarize how children in rural India interacted with 4 Western-style mobile games, and the playability problems that they encountered. Second, we report on 28 traditional games that rural children play in India, based on contextual interviews with 3 communities in North and South India. Third, we analyze the elements in these 28 games and identify the game mechanics found in traditional village games. We then compare these elements against recurring patterns in existing videogames to show what makes traditional games different from contemporary Western videogames. We conclude with a videogame based on these lessons, and describe how rural children found it to be more intuitive and engaging.

RELATED WORK

Sutton-Smith's work [11, 25] on children games is among the most established in the field, but he does not focus on games that children play in villages in developing regions. Instead, he focuses on the traditional games that children in industrialized nations play. With the exception of Narayan [20], most descriptions of traditional games either do not cover South Asia [5, 26] or cover urbanized variations of the same games [12, 27-29]. This paper thus contributes to existing documented accounts of traditional village games. Narayan [20] details the games played by tribal children in India, but does not attempt any analysis to inform design.

We are the not the first researchers to perform a comparison between digital and traditional games with the game design patterns in the compendium by Björk and Holopainen [6].

Loh and Seah employ these patterns to identify differences between WarCraft III and the Risk board game, to explore how successful traditional games can be adapted into digital games [18]. Our work has a much broader scope than [18], in that the traditional games in our comparison goes beyond one game in the tabletop family of traditional games, to the extent that we cover a total of 28 traditional games across several families.

Björk and Holopainen [6] is not the only work on design patterns for games. For example, there is the pattern library by Folmer [9], which we leave out from our comparison since it emphasizes game design patterns for accessibility and usability at the user-interface level, whereas our focus is at the level of gameplay mechanics and rules. Similarly, there is other work on game design patterns [e.g. 16, 17, 19, 22], but our comparison does not use these patterns because they target specialized game topics such as believable non-player characters, social networks, mathematical games and pervasive games, which are less relevant to poor children in the developing world. Björk and Holopainen [6] is currently the most comprehensive encyclopedia on *typical* patterns found in Western video and traditional games. Performing a comparison against [6] is therefore most practical for the purpose of targeting affordable gaming technologies in the developing world.

Work in the emerging area of game studies [24] provides a thorough treatment on game mechanics, including those in non-electronic games. But it does not systematically study how mechanics in videogames and traditional games differ. Designing videogames based on traditional village games is not the same as sports videogames [23], in that the former have mechanics that reflect a higher degree of informality.

Lastly, among work to promote children's education in the developing world with computing, Pawar et al. [21] aims to design e-learning games on multiple-mice computers. The Azim Premji Foundation [2] and Pratham [4] pursue similar initiatives with e-learning games. This paper will inform the above and new projects that aim to improve education in the developing world through games-based approaches.

EXPLORATORY STUDIES

At the time of writing, we have worked with low-income children in India since 2004 and have concluded six rounds of fieldwork [13-15]. Bilingual locals participated in our fieldwork as interpreters and cultural guides who helped us to understand the local cultural context. The initial studies were part of a broader needs assessment. In later studies, we investigated the feasibility of providing engaging learning experiences via mobile games. Specifically, we designed 10 games and tested them with rural children over 17 weeks. The games targeted ESL, which is one of the two highest educational priorities identified by rural parents in India.

In this section, we present unpublished results from some of the above studies. One of the studies has appeared in [14], but we have not been able to glean general principles on game design for rural children from it. We were therefore compelled to conduct similar studies with two additional communities. We will not delve into the study with the first community and refer the reader to [14]. In this section, we report unpublished qualitative observations that appear to repeat across multiple communities. Our goal in this section is not to be comprehensive, but to establish a context for the rest of this paper by sharing a few concrete observations.

Games

The early games (Figure 1) that we designed with the goal of investigating gameplay design with rural children were:

- *Crocodile Rescue*, where the player rescues the drowning boy by moving his boat to the boy within the time limit. The player is challenged with obstacles in the form of crocodiles, which he baits out of his path using chunks of meat in order to clear a path to the boy.

- *Dancer*, in which the player seeks to maximize his score within the time limit by throwing tomatoes to hit as many dancers as possible. The green- (red-) colored members in the audience give (take) a tomato to (from) the player when he moves to them. Members in the audience switch between green and red as the game proceeds.

- *Train Tracks*, where the player extends the railroad from the top-left hand corner of the game world to the bottom-right hand corner, before the train derails upon reaching the end of an unfinished railway track.

- *Frogger,* where the player is quizzed on various English words for animals. His goal is to select the correct animal and help it to cross the road without getting hit by traffic.

The game settings for Crocodile Rescue, Dancer and Train Tracks were chosen such that rural children could relate to them readily. We did not have any principles for designing games for rural children at that time, and instead borrowed features from successful casual games in Western societies. More details on our design process are given in [14].

The version of Frogger that we initially tested with the first community does not target English. But after observing that it tied with another game as the most popular game, we adapted it for ESL learning and tested it with all three rural communities. A plausible explanation for its popularity is that its goal (i.e. to cross the road) is situated in a familiar everyday setting – it is challenging to cross roads in India due to the lack of traffic lights and pedestrian crossings. In contrast, most games that we tested in the first community had goals that did not resonate with players, e.g. having to collect enough coins before being allowed to fight the boss.

Three Participant Communities

We tested the above games in the following communities:

- MYSORE: A rural public school in Mysore (Karnataka, South India) in a remote village that is seldom visited by outsiders. We tested Crocodile Rescue, Train Tracks and Dancer with 24 students in grades 1-2 (ages 6-7) and Frogger with all 47 students in grades 2-5 (ages ~7-13). 20 children, especially the older ones, have previously played a mobile game called "snake." This game involves moving a snake around to eat food objects while avoiding touching itself or the screen's boundaries.

- LUCKNOWPRIVATE: A private rural school in Lucknow (Uttar Pradesh, North India). Parents can afford the fees since they are landowners (vs. daily-wage farm laborers) who grow cash crops. This school has a computing center backed up by a power generator. We tested each game with 11 children in grades 2-3 (ages 8-10). Due to higher parental income, 2 of the children own low-cost, portable gaming devices. Similarly, unlike participants from the other 2 communities who may have only played "snake" on the cellphone, 4 students in this group have played 1-3 other mobile games on cellphones.

- LUCKNOWPUBLIC: Children attending public schools near LUCKNOWPRIVATE because their parents cannot afford to pay private fees. They participated in our research study after hearing about the opportunity to learn English in our project from neighbors who attend LUCKNOWPRIVATE. We tested each game with 10 children in grades 2-7 (ages 7-12). 3 of the 10 children have only played the "snake" game on cellphones previously.

As the wealthiest rural community among the above three groups, LUCKNOWPRIVATE provides a point of contrast that helps us contextualize our observations better. In particular, although it is not representative of average rural children, it allows us to observe how rural children's interaction with videogames varies with prior videogaming experience.

Key Observations

For each game, we introduced it by demonstrating it to the children in small groups. After which, each child receives a cellphone to play the game for about 1½ hours. We watched for playability problems and assigned severity ratings to the critical incidents. After sessions, we asked participants what they understood and perceived about the game. The most salient observations are:

- *Goals*. Almost every player immediately understood the

Figure 2. Some of the traditional village games that children in India play: (A) Gucchi Garam, (B) Siya Satkana, (C) Giti Phod and (D) Halla Guli Mane. In (A), a player stands in the safety of his circle and deflects a ball before it hits him. In (B), a player reaches to pick up the stick while avoiding being touched by the "it" player. In (C), a team attempts to rebuild the rocks into a heap while avoiding a ball thrown by the opposing team. In (D), players aim to move all the tamarind seeds into one crevice on the tray.

goal of Frogger. On the other hand, more than 50% of the participants in all three groups did not appear to find the process of exploring the Train Tracks game world to lay the railroad to be clear. Similarly, they seemed confused with the "bait" subgoal in Crocodile Rescue and did not attempt to achieve it in many cases.

- *Player actions*. Despite grasping the goal of Frogger, 33 out of 47 children in MYSORE attempted to find a straight route by waiting until there is no traffic on the next lane. They did not move sideways (i.e. left and right) along the current lane to slip into the gaps between vehicles on the next lane. Moreover, a child commented that his tortoise cannot cross the road because it is a slow-moving animal. In comparison, participants in LUCKNOWPRIVATE readily understood the need to move sideways although people usually do not cross roads in this way. It appears that the latter users could take advantage of this action, which is usually found in videogames, due to their prior exposure to electronic games. Children without this exposure seem to relate videogames to their daily experiences instead.

- *Difficulty level*. Just like the impassable terrains in Train Tracks, children playing Crocodile Rescue appear to find it frustrating to navigate a path to the destination square, especially when the number of obstacles (e.g. crocodiles) increases in the more difficult levels. More than 50% of the children in all 3 groups indicated that they disliked the crocodiles that obstructed their movements. Part of the problem was that participants in all 3 groups did not understand the "bait" action by the time their sessions ended. Some also seemed to struggle to determine if there was a clear path to the boy. Our observations for Dancer were consistent: participants appeared to become more stressed when there were more dancers to hit in the more difficult levels.

- *Resource management*. In Dancer, although users threw tomatoes enthusiastically at the dancers, only children in LUCKNOWPRIVATE could explain that they can gain more tomatoes by going to the green-colored members in the audience. In the other two communities, all but 3 users did not appear to know what to do once they run out of tomatoes, or that red-colored members in the audience would take their tomatoes, despite repeated explanations.

- *Score-keeping*. Most of the children in LUCKNOWPUBLIC and MYSORE did not pay attention to their scores during gameplay. For instance, when asked about why they liked Dancer, none of the Mysore participants cited the score-keeping mechanism as an appealing factor, despite being excited each time they complete a game level. In contrast, children at LUCKNOWPRIVATE were very competitive and compared their scores with their peers after finishing each game. A plausible reason is that test scores matter a lot in this school, unlike most government-run rural schools. We observed similar behaviors with Frogger.

TRADITIONAL GAMES
Clearly, designing a game to be culturally appropriate goes beyond situating its goals in an everyday setting. Frogger is instructive in showing that there are other components in a game such as player actions which must also be culturally meaningful. More generally, the above videogames did not completely match rural children's understanding of games. To design videogames that our target users can better relate to, it is timely to understand the traditional games that they play in their villages. We expect that digital games which incorporate familiar game mechanics from everyday village games will be more culturally meaningful to rural children.

Data Collection
We conducted contextual interviews with 87 children in the above 3 rural communities over 12 days, in which we asked participants to recall the everyday games that they love and to play these games for us to videotape. Participants did not appear to be self-conscious about us observing them since we had spent enough time interacting with them previously. Our contextual interviews were adapted for children [8], in that the brighter children helped us to understand the games that their peers – who were not always able to explain the rules of their games coherently – played in front of us. We had the chance to observe both outdoor and indoor games because the interviews took place during the monsoon.

The games appear to be a marker of social identity, in that children in the Lucknow studies were initially reluctant to tell us about their village games and shifted the interviews toward games that are more urbanized. It was only after we told them about some traditional games in South India and pointed out what we liked about them, that our participants

became less conscious about class differences and felt more encouraged to show us more of those games that they play with other children in their social classes.

We learn that some games have variations for different ages or genders, but we do not count these variations as separate games. The variations are significant, however, for e.g., in enabling us to understand how a game's difficulty could be adjusted to suit older players. Children from wealthier rural families also know about games that require relatively more expensive equipment (e.g. Chinese Checkers). However, we did not follow up on these games in our interviews because the majority of our respondents do not play or know them.

Games Overview

We observed a total of 23 outdoor and 5 indoor games, in addition to 4 variations on 3 outdoor games. In Figure 2, we show 4 games that are more exotic to a Western audience. 17 outdoor games belong to the family of "tag" games, in which there is generally at least one player designated "it" who has to "tag" players in the opposing team by touching them, either with a hand or an object. In particular, 2 and 3 "tag" games belong to the "cops and robbers" and "hide and seek" sub-families respectively. The 6 outdoor games that do not belong to the "tag" family include tug-of-war, kite flying, marbles, hopscotch and the spinning top.

The indoor games can be generally classified as "tabletop" games, although 3 of them (Halla Guli Mane, Chor Sipahi and Trump Cards) can be also played while sitting on the floor, i.e. only 2 of them (Pen Pick and Pen Fight) require a table. In Halla Guli Mane (Figure 2), there is a tray with 14 crevices. Players take turn to empty one of the crevices that belong to them by distributing all the tamarind seeds in it among other crevices. The game ends when all the seeds on the tray are in one player's crevices. In Chor Sipahi, each of the 4 players randomly chooses a folded slip of paper, after which one of them tries to guess who has the two slips with "chor" (i.e. thief) and "sipahi" (i.e. soldier) written on them. In Trump Cards, a pack of cards showing the attributes of World Wrestling Federation wrestlers is distributed evenly among everyone. Players take turns to compare an attribute on their topmost cards and the winner takes all the topmost cards. The game ends when one person acquires every card.

In Pen Pick, 6-8 pens are randomly scattered in a heap on a table, and each player has to take a pen without displacing other pens. In the Pen Fight game, there are 2 players, each of whom has a pen on a table. The goal is to flick one's pen as a "striker" to dislodge the opponent's pen from the table, while ensuring that one's striker does not overshoot and fall off the table.

Consistency Checks

We cannot describe the above games in greater detail due to space constraints. Some of the games have descriptions on Wikipedia [27-29] and websites on ancient Indian games [e.g. 12], and we refer the reader to them. As a consistency check, however, we learn that the traditional games which

we have seen differ from the online descriptions, which are variations played in urban areas. It seems that the variations played in villages involve simpler rules and less equipment.

Similarly, as another consistency check, we do not observe significant differences between the traditional games played in North vs. South India. Southern games typically involve players performing a skit before the game proper begins so as to situate the gameplay in a story, whereas none of the Northern games do. We do not notice other major regional differences. In fact, 14 out of the 28 games can be classified into 6 sub-families (e.g. "marbles," "cops and robbers"), such that each sub-family contains at least one game from each region. That is, more than 6 of the traditional games have variations that exist across geographic regions.

ELEMENTS OF TRADITIONAL GAMES

To understand the elements that comprise traditional games, we examined each of the above 28 games and identified its game mechanics for each of the 9 following categories. We next group the mechanics for all the 28 games according to these 9 categories:

- *Players involved, game elements and basic setup*. How many characters are there in the game, and do their roles differ? What elements in the game reflect the game state, such that the state can change through players interacting with these elements? What is the setup of the elements in the game that comprise the initial game state?

- *Goals and end conditions*. What are the goals that every player has to accomplish in the game? What conditions determine that a player wins, while others lose?

- *Rules, modes, actions and events*. What are the rules that determine what a player is or is not permitted to do? Does the game comprise modes such that the game rules vary according to the mode? What actions are players allowed to perform so as to modify the game state? What are the events that can arise from a player's action?

The above categories came from Björk and Holopainen's components framework [6], which lays out broad categories for the game mechanics (or components) that characterize the parts of a game. We draw on this framework since it is the most comprehensive framework we have encountered, to the extent that only the above 9 categories enumerated in this framework are relevant to traditional games. Since our objective is to understand village games in order to inform the design of digital games for rural children, as opposed to studying traditional games for their own sake, we abstract away the details on game mechanics that do not transfer readily to digital media (e.g. hopping on only one leg).

Players Involved, Game Elements and Basic Setup

In 20 out of the 28 games, players are organized into teams, such that each team constitutes an opposing side. In another 7 games, every individual player is an opposing side. A hybrid is Halla Guli Mane, in that it becomes a team-based game only when the number of players reaches 4, whereby

they are divided into 2 teams (i.e. pairs). A minimum of 3-6 players is required in most team-based games to ensure that there are enough players in at least one team. But teams do not necessarily need to have equal sizes, especially in "tag" games, because it is more conducive for enjoyable play to have many more players in the evading than pursuing team. None of the team-based game involves more than 2 teams, which implies that individual-based games are likely to have more opposing sides than team-based games.

The above details are relevant to videogame design because the number of players and their attributes (e.g. scores and positions) are part of the overall game state. Furthermore, in terms of the states that a player can be currently in, the most common is "currently active." A player who is active may be looking to catch someone, moving to avoid capture or in hiding. A player can be "at rest" and waiting to become an active player, e.g. an active player swaps his state with an inactive player, who is catching his breath, by touching the latter. A player can also be "imprisoned," i.e. frozen in his current spot and forbidden from moving to another place until he is rescued by his teammates. It is also possible to be temporarily "invulnerable" to being caught. Finally, players can be "out" of the game and awaiting its end so that they can begin in a new session. Player states can be transitive, i.e. a player who is touching an "invulnerable" player also becomes "invulnerable" himself.

The equipment in traditional gameplay are everyday objects that are readily available in villages. They include: the ball, stone, rocks, sticks, marbles, pens, slips of paper, cards, handkerchief, tray with crevices, top with an accompanying string to spin it and kite attached to a string to keep it within reach. Two properties of game objects are almost universal to the game state of every traditional game, i.e. an object's owner and its position. In particular, an object's position is a state variable in all 17 "tag" games and two additional outdoor games (hopscotch and tug-of-war).

Other pertinent state variables relate to the configuration of the rocks (to what extent are they stacked up in a heap with smaller rocks on top of larger ones, in the Giti Phod "tag" game?), configuration of the seeds in the Halla Guli Mane tray (who owns each crevice?, how many seeds are there in each crevice?), velocity of the top (is it spinning or has it stopped?), and the condition of the kite's string (has it been cut by an opposing team?). Moreover, equipment can have information written on them that are part of the game state, e.g. Trump Cards show wrestler attributes such as height.

Goals and End Conditions
Just like videogames, the player's objectives in a traditional game are organized according to a hierarchy of goals and subgoals. The goals that we have observed comprise:

- Be the *first* side to attain the end condition,

- *Minimizing* the time it takes for the game state to attain the end condition, e.g. be the first team to cut the kite,

- *Maximizing* the duration in which the game is in a state that does not satisfy the end condition, e.g. keep the top spinning for the longest time, or

- *Maximizing* variables in the game state, e.g. one's score or the number of certain resources that one possesses.

Next, the possible game states that determine the end of a traditional game are:

- When every player has his turn, or when a predetermined number of rounds have elapsed,

- When a certain number of players from a team enter a certain state, e.g. are "out" or "imprisoned" in the game, or accumulate a minimum number of points, or are in certain position(s), or

- When a certain number (or all) of objects enter a certain state, e.g. the top stops spinning or the kite's string is cut, or when a resource(s) is acquired by a player or team, or when an object(s) is moved to certain position(s).

A traditional game can also end through mutual consent.

Rules, Modes, Actions and Events
Just as opposing teams in the same game can have different sizes, units[2] can be heterogeneous with orthogonal actions and goals. In a total of 18 games, units in opposing sides are orthogonal to one another. In fact, units in every "tag" game are always orthogonal. Depending on which opposing side the unit belongs to, the most common roles are pursuers vs. evaders, or attackers/raiders vs. defenders. The only non-"tag" game whose units are orthogonal is Chor Sipahi, in which only the minister needs to guess the identities of the soldier and thief. The units in the remaining 10 games are homogeneous with the same goals and actions.

A traditional game can be turn-based, or allow players from every side to act simultaneously. In traditional games where units have orthogonal actions, players may switch sides in alternate turns (e.g. pursuers swapping roles with evaders), either on a turn-taking basis or when a pursuer(s) succeeds in capturing a victim. The state of a player and/or object may be changed when one player moves in order to:

- *Catch* an opponent by touching or grabbing him, in which case the person caught becomes "out" or "imprisoned,"

- *Evade* being touched by another player or hit by a projectile,

- *Protect* himself from capture by touching a tree, touching a team member who is already "invulnerable," or holding hands with a teammate, so that he himself becomes "invulnerable" to the touch of a would-be captor,

- *Guard* an "imprisoned" player by standing near him so

---

2 The unit in individual-based games and team-based games is the individual player and team respectively.

that none of his teammates would dare to rescue him for feature of capture,

- *Rescue* an "imprisoned" player from the same team by touching him,
- *Reach a destination*, which may be marked using a sign on the playing field, by walking or running, or
- *Rest* by tapping a team member who is "at rest."

In particular, there can be a limit on how many characters a player may capture at any time until he resets this counter by performing a certain action, e.g. by successfully moving back to his home turf first.

The actions that can be performed with objects are:

- *Throw* a ball at someone or a heap of stones (e.g. Giti Phod), stone into the given region (e.g. hopscotch), or top into a spin,
- *Deflect* an incoming ball using a stick (e.g. Gucchi Garam),
- *Pick up* an object such as a marble, pen or stick without being touched by the player designated "it" (e.g. Siya Satkana) or displacing adjacent objects,
- *Discard* an object such as a stick, handkerchief, or seed in a given location or player,
- *Strike* an object such as a pen or marble using a similar object as a "striker," or cut the string of a kite,
- *Arrange* rocks into a configuration (e.g. Giti Phod), or
- *Guess* the information written on an object such as a slip of paper (e.g. Chor Sipahi) or card (e.g. Trump Cards).

There can be interplays between the above "move" actions and object-oriented actions. For example, a player may also be prohibited from moving (e.g. to capture someone) when in possession of a certain object, which makes it necessary to discard it first.

In terms of the score-keeping mechanism, players may gain one point or a possession for performing a difficult action successfully, e.g. hitting a player from the opposing side on the leg with a ball. Conversely, if a player fails at an action, points can either accrue to the opposing team, or the player in question can lose a possession(s). When a player's score exceeds a threshold, he may gain the privilege to perform a one-time action (i.e. this action cannot be deferred).

CONTRASTIVE ANALYSIS
The above section has covered the game mechanics that are present in traditional Indian games. However, in order to better understand how traditional games might be unique, it is equally important to examine how the game mechanics in Western-style videogames are *not* present in village games, or vice versa. We use the adjective "Western" broadly to include videogames that originated from Japan and existing digital games developed for urbanized consumers in India.

We perform our comparison between traditional Indian and Western games by contrasting the above elements in the former against [6], which is a huge compendium of 296 design patterns that are commonly observed in videogames. In other words, we assume that this sample of 296 patterns is comprehensive to the extent that it is representative of the features in contemporary games. A pattern is a "template" description [1] of a solution to a recurring problem that has been solved. In this way, there is no need to reinvent the wheel, and new game designs can leverage on earlier games that have been successful. Patterns also capture contextual information such as domain applicability and its rationale. A pattern may also capture tacit knowledge on the domain after having evolved through iterative design cycles.

The patterns in [6] cover aspects of game design such as goals, rules, actions and heuristics for structuring games to be enjoyable. Although traditional games appear to overlap most with casual games or mobile games, we nevertheless consider design patterns from other genres, i.e. confining our comparative analysis to a few genres is only expected to prematurely narrow the space of future design possibilities that we seek to inform. For every pattern given in [6], we check if it is instantiated in any traditional game. For those patterns that are absent, we try to offer an explanation for why they are missing. For those patterns that are present, we attempt to identify if they are instantiated in a manner that is qualitatively different in Western videogames.

Differences from Western Videogames
In total, 74 out of the 296 patterns are completely absent from or instantiated differently in traditional Indian games. On closer examination, this proportion (25%) is lower than what we had originally anticipated because both categories of games incorporate several of the same design patterns on structuring game designs for enjoyment. That is, in spite of noticeable differences between both categories of games, it seems that a fair proportion of the principles and heuristics for enjoyable play are fairly universal across some cultures. Due to limited space, however, we will focus this section on only the most salient differences.

Players Involved, Game Elements and Basic Setup
Unlike real-time videogames where the game can advance according to a preprogrammed logic without players having to do anything, the game state in traditional games advance only when the players perform actions. Similarly, there are no system-generated events (e.g. earthquakes) in traditional games independent of the players' actions, possibly because none of these games have a dedicated game master.

Both traditional games and videogames can involve many players. However, social engagement and interaction appear to be much simpler in the former. In traditional games, the opposing sides are determined *before* gameplay and remain *stable* for the entire duration of the game. As such, while cooperation is required *among* team members in traditional games, teams and individual players do not form alliances

(whether covert or overt) with the opposing side, even when there are more than two sides in the games. In fact, we have not observed complex *inter-team* interactions, e.g. trading, negotiating or reciprocating obligations, in these games. On a related note, friendly-fire or betrayal is not possible since traditional games do not define actions that make it possible to inflict negative consequences on teammates.

With the exception of Trump Cards, none of the traditional games involve skills or statistics that enable a character to perform an action better than other characters. Furthermore, even though Trump Cards involve statistics, they are static and do not change *permanently*. As such, character or team development has no central role in traditional games, unlike videogames (e.g. role-playing ones) in which it is desirable to raise a skill level or gain the ability to perform an action that a character could not do previously. In other words, in traditional games, state variables for characters do not track skills because skill acquisition[3] is non-existent.

Similarly, since player characters come close to one another in their skill levels, there are no boss monsters in traditional games for players to defeat. Interestingly, although there are scores in both traditional and videogames alike, the score-keeping mechanism differs significantly. More specifically, while players in videogames typically gain many points for each sub-goal that is successfully achieved and accumulate relatively high total scores, only one traditional game has a similar reward structure. In the remaining 6 village games that implement score-keeping, a player's score increments by one at each step, and he has to expend a lot of effort to earn this point. Hence, the total score rarely exceeds 10. A plausible explanation is that larger magnitudes are difficult given the limited numeracy skills of the average rural child.

Lastly, in village games, no resources are hidden or secret, i.e. the information pertaining to each object's ownership is known to everyone. Moreover, although some actions are carried out with certain objects (e.g. deflecting an oncoming ball with a stick, in Gucchi Garam), no object in the game world is sought after because it imbues its owner with a special ability. That is, skill-enhancing objects do not exist. In fact, objects in traditional games are mostly meant to be acquired or moved around only.

Goals and End Conditions
The goal structure in traditional games is less complex, such that there are no goals which are:

- *ephemeral*, i.e. existing for a certain period of time only,

- *continuous*, i.e. having to maintain the game in a certain goal state for a certain period of time,

- *excluding*, i.e. a goal become meaningless once another goal has been achieved,

---

[3] For game characters, not players. The latter can continue to improve their skill at the game over time.

- *incompatible*, i.e. the game states for two or more goals are mutually exclusive, such that achieving one subgoal or goal precludes the attainment of other goals,

- *selectable*, i.e. the player can choose to achieve a subset of goals from a set of possible goals, or

- *unknown*, i.e. goals that are not known to the players.

Next, at the more concrete level of specific goals, since the playing field in traditional games is visible to all, exploring an unknown territory is not a meaningful goal, even though this goal is found in some videogames. Similarly, having to clear a path to a destination by removing obstacles (e.g. in Sokoban) is never a primary goal in traditional games.

More important, while there are goals in traditional games, 3 out of 28 of the village games do not have end conditions, i.e. play continues after the goal is achieved, and the game only ends through mutual consent when everyone is tired or bored. In contrast, with the exception of a few games such as massively multi-player ones, the majority of videogames end after certain conditions are attained. In other words, a traditional game can be played to experience the gameplay process without needing to win.

The relationship between goals and subgoals in traditional games is particularly interesting. While videogames can be designed to offer more difficult levels of challenges through more – and possibly faster moving -- enemy characters, the number of players and their speed have physical constraints in kinesthetic games and cannot be increased arbitrarily to make the game any more difficult. As such, we observed in variations of the Kabbadi "tag" game, the version played by older children is more difficult because it introduces an additional subgoal, i.e. having to touch a marked spot in the opponent's turf before one is allowed to win that round by returning safely to one's turf. This observation suggests that introducing appropriate subgoals into a videogame for rural children is a natural guideline for raising difficulty levels.

Rules, Modes, Actions and Events
Since village games hardly involve elaborate score-keeping mechanisms, player characters do not have "hit" points. As such, while it is possible to eliminate a player entirely, it is not possible to "damage" him partially. In other words, an offensive action has an *atomic* effect, i.e. it either eliminates entirely or fails to do so. Furthermore, there is no extended action in traditional games, as in, an action takes effect as soon as it is performed. Most of all, even though traditional games share several similarities with arcade games, there are no "combo actions" in the former. What we mean is that when multiple actions are performed in traditional games, the cumulative effect is the additive effect of each separate action. Whereas with "combo actions," there are outcomes (or non-linearities) that are more than the individual effects of the individual actions.

On the other hand, traditional games have elaborate rituals associated with physical movements and the playing space,

which are usually not observed in videogames. One of them concerns that of the "turf," which is a region that is often associated with an individual owner or team. A turf can confer a benefit to its owner when he is standing inside (e.g. invulnerability, as in Gucchi Garam), by being "off limits" to members of the opposing team, or imposing a time limit on how long members of the opposing team can spend in it. However, a player may not necessarily be allowed to return to his turf freely, in that he may need to have satisfied some condition(s) first.

Conversely, a turf may be disadvantageous by imposing restrictions, e.g. allowing the player to run around a circle either in a clockwise or anti-clockwise direction only, as in Ghoda Jamal Khaye; or allowing the player to run on only one side of a line, as in Kho Kho. More interestingly, these restrictions are not necessarily fixed in the rules, in that the player can choose which direction or side he can run on for the current round. Finally, a player may be prohibited from performing certain actions outside his turf.

On the same note, while players may move around freely in village games that entail outdoor movements, these games do not have playing fields that contain inaccessible areas or obstacles. This is a contrast to the videogames that contain such challenges in the game world, which make it necessary for the player to navigate a path around the obstacles. It is also interesting that while videogames may include traps in the game world, traditional games do not involve traps.

Since objects in traditional games are physical equipment, these game resources are fixed and are available in highly limited quantities. As such, while they can be eliminated, they are also non-renewable, i.e. new resources cannot be created in a game session. Similarly, it is not possible to create new units during gameplay, unlike digital games that make resource management a central goal. By implication, resources in traditional games cannot be invested to reap more future resources.

GAME REDESIGN
Based on the insights from the above analysis, we design a cellphone-based game called Tree-Tree (Figure 3) mirrored after the "tag" family of traditional games. Tree-Tree aims to help the player acquire an English vocabulary of everyday fruits in India. Every tree in the game stands for a unique fruit, and a computer-controlled character calls out one of these fruits. The player needs to move to and touch the corresponding tree, so that he is invulnerable from capture by a computer-controlled opponent. While moving, he also has to evade capture from the pursuing opponent.

We evaluated Tree-Tree with 21 children aged 8-14 from LUCKNOWPUBLIC. Each child had up to 3½ hours with the game. 12 children were videotaped, after which their video recordings were transcribed. Whereas we sometimes spent days to explain Train Tracks and Crocodile Rescue to rural children in previous studies, almost all participants grasped the goal and rules of Tree-Tree after we demonstrated the

game to them. In particular, some participants were visibly excited since they could relate easily to the game.

Similarly, players seemed to concentrate hard when moving to the appropriate tree, while doing their utmost to avoid the opponent at the same time. At least 3 participants enjoyed enticing the opponent to draw near before they ran away in another direction. Children often employed this strategy in their village games, and this degree of engagement was a noticeable contrast from their frustration or boredom with previous games. In fact, at least 2 players were so engrossed in the game that they failed to notice what was happening around them. Furthermore, 4 players found Tree-Tree to be easy due to their familiarity with similar traditional games, and asked if it could be made more difficult.
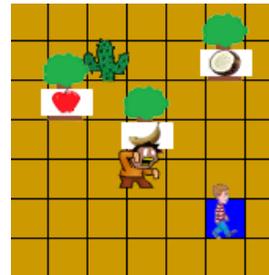
Figure 3. Tree-Tree game, mirrored after "tag" village games.

More important, at least 2 players repeated the spellings and pronunciations of the fruits aloud after the game, without our prompting. In future research, it would be interesting to explore how we can design educational games – modeled after selected aspects of traditional games – that show rural children how to *transfer* the subject matter from the digital game back to their everyday village games. For example, players could be encouraged to play a non-digital variation of Tree-Tree among themselves, in which they spell out the English words for the fruit trees in the playground.

CONCLUSION
Through our earlier attempts to design videogames that are intuitive to rural children, and exploratory studies in India, we found that situating game settings in everyday scenarios is necessary but insufficient. We have learned about 28 traditional village games through our contextual interviews, analyzed the elements in these games and studied how they differed from contemporary Western videogames.

The analysis have enabled us to interpret playability issues with Frogger, Dancer, Train Tracks and Crocodile Rescue. We now realize that our prior experiences with Western-style games have led to these cultural expectations creeping into our processes and design outcomes for these 4 games. Dancer is reminiscent of "tag" games that require the player to eliminate opposing players by hitting them with a ball. The goal in Frogger is similarly intuitive. On the other hand, having to explore an unknown world in Track Tracks to lay railroads is a non-intuitive goal. Users also appear to understand the actions in Dancer (e.g. throwing tomatoes, moving among the audience) more readily than the "bait the

crocodile" action in Crocodile Rescue. Similarly, there are players who struggled to make sense of the subgoals related to resource management in Dancer, where they gain more tomatoes by approaching green-colored members of the audience. These observations are highly consistent with the above analysis on the game mechanics that are found – and *not* found – in traditional games.

A critical ingredient for a game to be enjoyable is that it has to be challenging without being too difficult. Even though we designed Crocodile Rescue such that there are more stationery crocodiles in higher levels, players did not find it easy to navigate the "maze." Similarly, navigating around impassable terrains in Train Tracks seems to be an unfamiliar task. Players also did not like the fact that there are more dancers on stage to hit in the more difficult levels in Dancer. In other words, increasing a game's difficulty by raising the number of obstacles or enemies is inconsistent with how the difficulty in traditional games is scaled up. In hindsight, we should have designed the advanced levels to be harder by incorporating more subgoals into them instead.

Our results with Tree-Tree suggest that designing digital games with the same game mechanics as traditional games, while leaving out those mechanics that are absent, ensures the most successful videogame designs that rural children can relate to more readily. We hope that other researchers and practitioners working on videogames to improve lives for poor children in the developing world will experiment further with the results from our analysis.

REFERENCES
1. Alexander, C. *A Pattern Language: Towns, Buildings, Constructions*. Oxford University Press, 1977.
2. Azim Premji Foundation. *Impact of Computer Aided Learning on Learning Achievements: A Study in Karnataka and Andhra Pradesh*, 2004.
3. Azim Premji Foundation. *The Social Context of Elementary Education in Rural India*, 2004.
4. Banerjee, A., Cole, S., Duflo, E., and Lindon, L. Remedying education: Evidence from two randomized experiments in India. *NBER Working Paper No. 11904*, December 2005.
5. Bell, R.C. *Board and Table Games from Many Civilizations*. Dover Publications, 1979.
6. Björk, S., and Holopainen, J. *Patterns in Game Design*. Charles River Media, 2005.
7. *Bollywood Films Fuels Mobile Gaming Industry*. The Times of India, May 8, 2006.
8. Druin, A. 1999. Cooperative inquiry: developing new technologies for children with children. In *Proc. CHI 1999*, ACM Press (1999), New York, NY, 592-599.
9. Folmer, E. Interaction Design Pattern Library for Games. http://www.helpyouplay.com/
10. Gee, J.P. *What Video Games Have to Teach Us About Learning and Literacy*. Palgrave Macmillan, 2003.
11. Herron, R.E., and Sutton-Smith, B. *Child's Play*. John Wiley & Sons, 1971.
12. India Visit Information. *Sports in Ancient India*. http://www.indiavisitinformation.com/india-sports/sports-ancient-india.shtml
13. Kam, M., Ramachandran, D., Devanathan, V., Tewari, A., and Canny, J. Localized iterative design for language learning in underdeveloped regions: The PACE framework. In *Proc. CHI 2007*, ACM Press, NY, USA.
14. Kam, M., Rudraraju, V., Tewari, A., and Canny, J. Mobile gaming with children in rural India: Contextual factors in the use of game design patterns. In *Proc. 3rd Digital Games Research Association International Conference,* 2007.
15. Kam, M., Agarwal, A., Kumar, A., Lal, S., Mathur, A., Tewari, A., and Canny, J. Designing e-learning games for rural children in India: A format for balancing learning with fun. In *Proc. DIS 2008*, ACM Press, NY, USA.
16. Lankoski, P., and Björk, S. Gameplay design patterns for believable non-player characters. In *Proc. 3rd Digital Games Research Association International Conference,* 2007.
17. Lankoski, P., and Björk, S. Gameplay design patterns for social networks and conflicts. In *Proc. Computer Game Design and Technology Workshop 2007*.
18. Loh, S., and Seah, H.S. Comparing computer and traditional games using game design patterns. In *Proc. 2006 International Conference on Game Research and Development*, ACM Press, 237-241.
19. Mor, Y., Winters, N., Pratt, D., and Björk, S. Tools for developing design patterns for mathematical computer games. In *Proc. Game in Action Conference 2007*.
20. Narayan, S. *Play and Games in Tribal India*. Commonwealth Publishers, New Delhi, India, 1995.
21. Pawar, U.S., Pal, J., Gupta, R., and Toyama, K. Multiple mice for retention tasks in disadvantaged schools. In *Proc. CHI 2007*, ACM Press, NY, USA.
22. Peitz, J., and Björk, S. Understanding pervasive games through gameplay design patterns. In *Proc. 3rd Digital Games Research Association International Conference,* 2007.
23. Rollings, A., and Adams, E. *Andrew Rollings and Ernest Adams on Game Design*. New Riders, 2003.
24. Salen, K., and Zimmerman, E. *Rules of Play: Game Design Fundamentals*. The MIT Press, 2003.
25. Sutton-Smith, B. *The Psychology of Play*. Arno Press, 1976.
26. *Traditional Children's Games from Around the World*. Topics Online Magazine, Issue 11. http://www.topics-mag.com/edition11/games-section.htm
27. Wikipedia. Kabbadi. http://en.wikipedia.org/wiki/Kabaddi
28. Wikipedia. Kho-Kho. http://en.wikipedia.org/wiki/Kho_kho
29. Wikipedia. Tag (game). http://en.wikipedia.org/wiki/Tag_(game