# When a Console Game Becomes CSCL: Play, Participatory Learning and 8-bit home computing in India

Derek Lomas, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA 15213 USA, dereklomas@cs.cmu.edu
Dixie Ching, New York University, 239 Greene St. Suite 300, New York, NY 10003 USA, dixie@nyu.edu
Christopher Hoadley, New York University, 239 Greene St. Suite 300, New York, NY 10003 USA, cscl11playpower@tophe.net
Kishan Patel, Dhirubhai Ambani Institute of ICT, Gandhinagar Gujarat 382007 India, kishan_patel@daiict.ac.in
Matthew Kam, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA 15213 USA, mattkam@cs.cmu.edu

**Abstract:** This paper presents evidence describing how a single player typing game, designed for use on a low-cost (~US$10) computing platform, was utilized as a computer-supported collaborative learning activity. The group computer interaction was found to consistently induce verbal language experiences that extended the potential educational utility of the highly limited 8-bit computing platform. Building on these experiences, we describe some of the design implications for promoting participatory learning with video games, particularly in low-income households and developing contexts.

## Introduction

CSCL (Computer Supported Collaborative Learning) applications have traditionally focused on technologies that directly support person-to-person interaction, mediated by a computer. But CSCL can also broker virtual connections between people outside the system (Hoadley & Pea, 2002) or around the system in a physically shared context (Roschelle & Pea, 2002). As gaming becomes a more important educational technology strategy, we face a similar set of design challenges: games can be designed for individual use, for directly mediated group use, and, importantly, for indirectly mediated group use. We describe how this issue plays out in the widespread but understudied context of 8-bit home computing in developing countries.

Our research team has conducted an investigation of 40 low-income households in two cities in India to understand the design context in which 8-bit games might lead to learning. We then deployed 20 8-bit computers in a subset of these households in order to understand how families learned and used the TVC. In this paper, we describe the appropriation of one game that, although designed for solitary use, in actuality engendered significant collaborative and participatory gameplay. Though our observational data, we argue that designing for developing contexts should take into account the collaborative and group nature of the interaction likely to occur, even for seemingly single-player games.

## About the Platform

8-bit TV computers (TVCs) are a popular computing and gaming device found widely in India and other developing world markets. The processing unit is contained within a keyboard; a TV set typically serves as the monitor (see Figure 1). The TVC is sold in India for $8-25, making it an affordable option among the "emerging middle class," which, in India alone, comprises over 300 million people with household incomes between $80-150 per month. The TVC is based on hardware components similar to the 8-bit *Nintendo Family Computer*, or Famicom, which was marketed in the US as the *Nintendo Entertainment System.* It was a popular 1980s-era video game console associated with classic games such as *Super Mario Brothers*. Like the NES system, the TVC uses the 8-bit 6502 microprocessor just like the Apple II, Commodore 64, BBC Micro, and Atari 800.

The TVC is typically sold with two game controllers, a light gun, and two game cartridges, an "education" cartridge and an "entertainment" cartridge. The games on the "educational" cartridge, which includes a few typing games and an alphabet learning activity, are typically of poor pedagogical quality, especially when compared to the 8-bit educational games developed for the Apple II in the 1980s, such as *Number Munchers, Where in the World is Carmen San Diego, Robot Odyssey* and *Oregon Trail.* In 2009, a volunteer game development community (Playpower.org) was founded to address this content issue, with the rationale that a significant educational impact could be made in these low-income households if pedagogically-sound, culturally-relevant games could be provided for the TVC.

In the winter of 2009, a game design workshop was held in Hyderabad, India, with 12 Indian undergraduate students attending. Participants analyzed historical learning games and learned basic principles of instructional game design; a modified version of the IDEO Human Centered Design (HCD) Toolkit was used to identify appropriate opportunities. Typing skills were identified as a target area, both because of the poor quality of existing typing games currently available on the device and the economic value of typing skills. A storyboard for *Hanuman, Typing Warrior* was developed, based upon a popular tale in the Indian epic *Ramayana*, in which

the monkey-like god Hanuman must travel to a far away mountain in the Himalayas to fetch a life-saving herb for his friend Lord Laxman. After the workshop, game development continued by an international team of volunteer game designers and service learning student programmers in India (see http://vimeo.com/16327114).

Successfully completing each level in *Hanuman, Typing Warrior* (Figure 1c) requires the ability to type with increasing accuracy and speed. The player makes Hanuman (1) walk forward by typing the letters of the word; the correctly typed letters are underlined (3) to indicate the next letter to be typed. The first part of the text is consequence free, in that the player is not penalized for slow or inaccurate typing. Once the player begins typing the second word on the screen (4), each correctly typed letter causes Hanuman to strike the monster (2). However, if the player does not type a letter fast enough, the monster strikes back at Hanuman. When Hanuman is hit, he is flung back across the screen and must retype until the player learns to type the phrase well enough to defeat the monster.


Figure 1. The TVC Platform. Figure 1a. Typical packaging; Figure 1b. Children playing an included typing game, Ahmedabad, India; Figure 1c. Annotated screenshot from *Hanuman, Typing Warrior*.

## Methods

This paper reports on the results of contextual interviews and field observations of families in a rapid ethnography, contextual design process (Holtzblatt, Wendell, & Wood, 2005; Millen, 2000). After receiving training in ethnographic fieldwork, local students recruited and interviewed 20 lower-middle class families ($80-$300/month/household) about existing patterns of technology use and gave each family a TVC. The researchers conducted a follow-up interview after two weeks to understand device use and adoption, then visited a week later to observe how the children played their favorite video games on the TVC. Finally, after the families had possession of the TVC for approximately 4 weeks, an extended (90-180 minutes) game observation session was conducted with 14 of the 20 families. A significant portion of the game observations was spent observing how the families played *Hanuman, Typing Warrior*.

The purpose of the research was descriptive, specifically to identify key contextual constraints and affordances in the use of Playpower games on the TVC platform. Tapes of family interactions with the hardware were transcribed and analyzed. Although these prototype games were designed with individual play in mind, the data clearly showed how the games were, in fact, appropriated such that they were played collaboratively. Below, we describe some of the evidence showing how one Playpower game afforded collaboration and discuss some of the design implications of the collaborative use of the game in this context.

## Results and Discussion

In general, we observed a wide range of group activities emerge around the playing of these video games; these group activities appeared sometimes to enhance the player's learning and sometimes to impede it (though often as a result of another audience member who took over playing). Below, we describe one case in detail, and describe a range of other structures of participation observed across all the families. We then consider the motivations for participation and the possible effects of this activity on the learning process.

Our example case occurs in a household in which both parents worked (household income of ~US$80/mo.) in order to support their five children ranging in age from one to fifteen. All but the youngest of the children were in school, and two daughters had a fair grasp of English. The introduction of the device had some impact on family dynamics: in the initial interview, the father reported little interaction with his children, but after the introduction of the TVC he described how he enjoyed playing videogames with his son and daughters after work. While the father and son had priority, the three girls also played regularly after school. The mother, however, expressed a fear of breaking the device and did not use it, nor did nonfamily members.

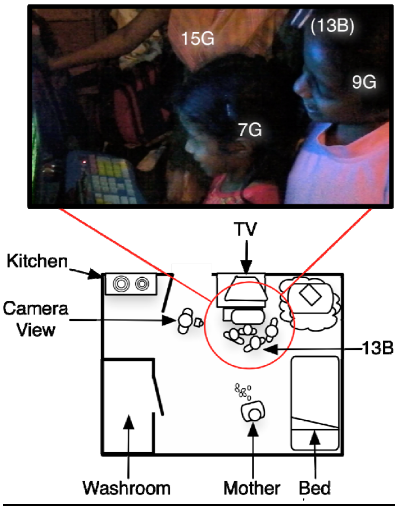
Below (see Table 1) is an activity transcript of 40 seconds of game use filmed by the researchers. The participant codes reflect age and gender (e.g., 7G is the seven-year old girl). As the following transcript illustrates, the children collaborate on the typing task and not only align their attention to the progress of the player

in the game, they distribute the work across multiple people, compete for the computer resource, scaffold each other, and generally construe the task of playing the video game socially. In this transcript, the children are trying to quickly type a phrase as it appears on screen before a monster is able to strike their game character.

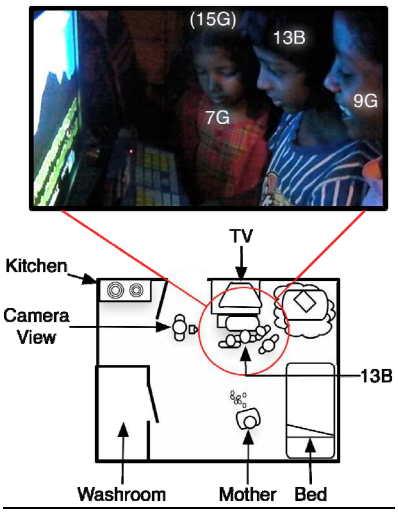
Table 1: Transcript of one *Hanuman, Typing Warrior* game session from Household BC.

The images below show the physical positions of the participants in their home, over the course of the play session.

**0 Seconds:**




**40 Seconds:**




**Context:** A 7-year-old girl (7G) is playing *Hanuman, Typing Warrior* with her siblings. Her two older sisters (9G and 15G) and older brother (13B) are looking on and helping her play. 9G had been playing for 5 minutes previously, but had reached a challenging stage where, due to slow typing, a monster was able to strike her game character, Hanuman. As the phrase of words had to be retyped, 9G deferred to her younger sister 7G, who wanted to play. Their older brother (13B) also wants to play. The following sequence shows the cooperative and competitive interactions occurring between the primary player and the surrounding participants.

**0 Seconds**
*The words "DEFEAT MONSTER" are presented on the screen.*
**7G:** *Looks at screen then looks down and presses D on the keyboard. As she looks back up at the screen, she says* "D".
**7G:** *Looks back down at the keyboard and presses E. Says* "E."
**7G:** *Looks up at screen. Says* "F," *then looks down and presses F.*
**9G:** *Says,* "E… E,"
**7G:** *While looking down, presses E. Then looks up and scratches head. Says* "E," *then looks down at keyboard.*
**13B:** Says "A" as she r*eaches over 7G's shoulder towards the keyboard.*
**10 Seconds**
**7G:** *Presses A and then looks up. Says* "A," *then looks down.*
**7G:** *Presses T, looks up and says* "T". *Looks down again.*
**9G:** "M." **13B:** "M."
**7G:** *Presses M. As she looks up, she says* "M," *then looks down.*
**13B:** "O."
**7G:** *Looking down, presses O and says* "O." *Presses N, then looks up. Says* "N" *and looks back down.*
**13B:** "S." **9G:** "S."
**7G:** *Presses S but it doesn't work. Looks up, says* "S" *and looks down.*
**9G:** "T." *The snake reaches out and strikes the Hanuman character.*
**9G:** "Noo…"
**22 Seconds:**
*7G's older brother 13B moves into the space by the keyboard, while 7G steps to the side. 13B begins to type, with index fingers of both hands extended. The words "DEFEAT MONSTER" are again presented on the screen.*
**13B:** *Presses D and says,* "D."
**7G:** "E..." **13B:** Says "E," *then searches for this button and presses it.*
**30 Seconds:**
**7G:** "F..." *7G puts her finger over the F button but does not press it. 13B pushes down on 7G's finger to press button.*
**13B:** "F." *13B pushes 7G's hand away from the keyboard.*
**9G:** "E"
**7G:** "E." *7G reaches over and presses E.*
**13B:** "E." *13B looks around then pushes at the air above the keyboard where 7G's hand was.*
**13B:** "A." **9G:** "A."
*9G reaches over and presses A. 13B pulls 9G's hand away from the keyboard. 9G tries to press T but 13B pulls 9G's hand away again.*
**7G:** "T, T." **13B:** *presses T for himself.* "T."
**40 Seconds**

The use of this presumably individual technology is actually very much a collaborative learning setting. At a descriptive level, there were numerous types of social-computer interaction that can be identified within this transcript. To begin with, the non-players are clearly engaged in watching the gameplay and the game player's actions. Non-players appear to comprehend the goals and sub-goals presented by the game, such that they respond verbally to the successes and failures in the game. The basic engagement of the audience in a game played by another person is the basis of further participation and collaboration, such as the reading of the letters aloud.

Like many video games, this game created a competitive desire within the audience to dominate the control of the gameplay. This competition for dominance over the device was informally resolved by turn-taking, which typically followed a mistake by the dominant player. For instance, in the minute prior to the transcript, 9G was the dominant player. However, after she failed to type quickly enough to avoid being hit by the monster in the game, she ceded game control to 7G. Then, the transcript shows how 13B quickly moved in to take control after 7G was hit. Non-dominant players can still participate in the game, however, as demonstrated by 9G and 7G when they continued to type letters even after 13B was in the dominance position. In contrast to a game pad, the keyboard is a large enough input device that multiple persons can visually search the space for the correct key at a time.

Interaction patterns observed among home inhabitants using the TVC reflect what has been reported in both formal (Parikh & Ghosh, 2006) and informal learning settings (Dangwal, Jha, Chatterjee, & Mitra, 2005). In low resource environments, individuals often crowd around a single device, with a dominant user at the controls (e.g., keyboard, mouse, gamepad). Such hierarchical dynamics of "sharing" raises issues of inequities in learning, especially with regards to children from poor settings (Pal, Patra, Nedevschi, Plauche & Pawar, 2009). Several lines of research address how to create more equitable learning environments where limited computing resources do not allow each participant to have his or her own interface. Pal et al. (2009) found that increasing opportunities to interact with the technology was not the sole determining factor in improving learning outcomes; providing motivations to collaborate was also key. Other paradigms for fostering equitable multi-user interaction with interfaces include encouraging peer learning by leveraging personal social networks (Dangwal & Kapur, 2008, 2009) and peer-mediated cooperative learning processes and positive group dynamics (Sahni, et al., 2008; Hoadley, Honwad & Tamminga, 2010). Overall, while many of these studies on learning in developing countries have focused on cooperative learning in formal and informal school-based environments, it is equally important to examine cooperative learning in homes in the developing world, another important nonformal context.

The work of Satwicz and Stevens (2007) can inform our discussion of the cooperative behaviors that we observed during gameplay. In their observations of videogame play in the home among three siblings, they highlight how the individual creates a meaningful collaborative learning environment by shifting elements in his or her "socio-technical learning system" (p. 634) comprising people, games, characters, and actions. Stevens, Satwicz, and McCarthy (2008) go on to argue that these emergent, self-organized "flexible learning arrangements" have educational potential because they lead to opportunities for "sociality, joint projects, and empowerment through sharing one's knowledge and seeing it used for concrete success by others" (p. 52-3). In particular, this perspective helps conceptualize the most surprising form audience participation in *Hanuman, Typing Warrior*: the audible reading aloud of the letters by the players and the non-players.

Letter reading was a spontaneous activity that was observed in nearly all households, which is notable since the children's first language does not use the Roman alphabet. Like most players we observed, 7G said the letter aloud while looking back up at the screen, just after she typed it, as though to verbally confirm her action. However, the audience members tended to say the letters before they were typed, as though to help the player know which letter should be typed next. In several instances within the transcript, the non-players are able to alert the player to their typing errors by repeating letters that were not successfully typed. The typing skills in the game are supported by fluency with both the English words and the script used to write them. Even children who are not actively typing could practice letter recognition and articulation. It is important to note that this oral practice is a vital strategy for language acquisition, and while the computer did not directly support this practice, this important learning activity seems to be fostered as an artifact of collaboration with the technology.

In *Hanuman, Typing Warrior*, the player's attention shifts from screen to keyboard. This conspicuous head motion may signal to the audience the specific goals and challenges facing the player, prompting the assistive response of reading the letters aloud. Because children are known to have a remarkable ability to infer the goals of other people as well as the motivation to spontaneously support those goals (Tomacello, 2008), even game spectators can become valuable learning partners, supporting their peers in a form of a mutual cognitive apprenticeship (Collins, 1991). In contrast to standard groupware interfaces that mediate collaboration directly, we believe further research is needed to understand how to design good CSCL in order to engage spectators both as learners and as learner scaffolds.

## Conclusion

An 8-bit computer has a very limited capacity to produce or recognize speech sounds. And yet, during the social gameplay we observed across multiple households, the design of *Hanuman Typing Warrior* was able to consistently induce players to pronounce English letters and to respond to the letters spoken by other children. We view the highly participatory environment that surrounds the TV-computer in small, low-income Indian households as a valuable counter-weight to the inherent limitations of the low-cost, 8-bit device. Because audience members can scaffold a player's understanding of the software, designers should ensure that the game's goals are visible and comprehensible to a non-playing observer, since the visible challenge of game

tasks may help encourage audience participation and support. Additionally, by conceiving low-cost devices (such as the TVC) as an opportunity to foster CSCL, designers can help provide cost-effective, culturally compatible supports for learning in underserved communities.

## References

Collins, A., Brown, J. S., & Holum, A. (1991). Cognitive apprenticeship: Making thinking visible. *American Educator*, 6-11, 38-46.

Dangwal, R., Jha, S., Chatterjee, S., & Mitra, S. (2005). A model of how children acquire computing skills from hole-in-the-wall computers in public places. *Information Technologies and International Development*, 2(4), 41-60.

Dangwal, R., & Kapur, P. (2008). Children's learning processes using unsupervised "hole in the wall" computers in shared public spaces. *Australasian Journal of Educational Technology*, 24(3), 339-354.

Dangwal, R., & Kapur, P. (2009). Learning through teaching: Peer-mediated instruction in minimally invasive education. *British Journal of Educational Technology*, 40(1), 5-22.

Hoadley, C., Honwad, S., & Tamminga, K. R. (2010). Technology-supported cross-cultural collaborative learning in the developing world. In P. Hinds, A.-M. Søderberg, R. Vatrapu, T. Ishida, M. Maznevski & G. M. Olson (Eds.), *Third International Conference on Intercultural Collaboration* (pp. 131-140). Copenhagen: Association for Computing Machinery.

Hoadley, C., & Pea, R. (2002). Finding the ties that bind: Tools in support of a knowledge-building community. In K. A. Renninger & W. Shumar (Eds.), *Building virtual communities: Learning and change in cyberspace* (pp. 321-354). New York: Cambridge University Press.

Holtzblatt, K., Wendell, J. B., & Wood, S. (2005). *Rapid contextual design: a how-to guide to key techniques for user-centered design*. San Francisco: Elsevier/Morgan Kaufmann.

Millen, D. R. (2000). *Rapid ethnography: time deepening strategies for HCI field research*. Paper presented at the Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques, New York City, New York, United States.

Pal, J., Patra, R., Nedevschi, S., Plauche, M. & Pawar, U.S. (2009). The case of the occasionally cheap computer: low-cost devices and classrooms in the developing world. *ITID: Information Technology and International Development*. Cambridge, MA: MIT Press.

Parikh, T., & Ghosh, K. (2006). Understanding and Designing for Intermediated Information Tasks in India. *IEEE Pervasive Computing Magazine*, 5(2), 32-38.

Roschelle, J., & Pea, R. (2002). *A walk on the WILD side: How wireless handhelds may change CSCL*. Paper presented at Computer Support for Collaborative Learning (CSCL), Boulder, CO.

Sahni, U., Gupta, R., Hull, G., Javid, P., Setia, T., Toyama, K., & Wang, R. (2008). *Using digital video in rural Indian schools: A study of teacher development and student achievement*. Presented at Annual meeting of the American Educational Research Association, New York, NY.

Satwicz, T. & Stevens, R. (2007): Tools of play: coordinating games, characters, and actions while learning to play video games. In *Proceedings of the 8th International Conference on Computer Supported Collaborative Learning* (pp. 633-642). New Brunswick, NJ.

Stevens, R., Satwicz, T., & McCarthy, L. (2008). In-Game, In-Room, In-World: Reconnecting Video Game Play to the Rest of Kids' Lives. In K. Salen (Ed.), *The Ecology of Games: Connecting Youth, Games, and Learning*. The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning. Cambridge, MA: The MIT Press.

Tomacello, M. (2008). *The Origins of Human Communication*. Cambridge, MA: The MIT Press.

## Acknowledgments

We gratefully acknowledge the participation of the families in Ahmedabad and Bangalore in this research, which was funded by a "Digital Media and Learning" award from the MacArthur Foundation, the HASTAC digital collaboratory, the CMU HCI Institute, and a grant from the IES PIER program.

Student Game Development Team: Revoori Vishvesh, Vivek Fitkariwala, Kishan Patel, Parth Rao, Ankit Patel, Dheeraj Medikonda, Darsh Shah, Yash Soni, Anshul Pahwa.

Student Fieldwork Team: Aliya Pabani, Alisha Panjwani, Tanvi Srivastava, Pranav Patadiya, Parth Rao, and Sonali Dubey. Field Research Training: Meera Lakshmanan. Additional thanks to all the Playpower.org volunteers and the #NESDEV community, in particular Don Miller (NO CARRIER). Game graphics by Jeremy Galante and Alex Bond (ENZO).