Olive Dreams of Elephants: Game-Based Learning for School Readiness and Pre-literacy in Young Children

Carly A. Kocurek and Jennifer L. Miller
Illinois Institute of Technology, Chicago, USA
ckocurek@iit.edu

Abstract. School readiness remains a major challenge in the United States educational system. Research consistently shows significant disparities in pre-literacy skills and language acquisition based on socioeconomic class emerging within the first 18 months of childhood. Simultaneously, access to media devices such as smart phones and tablets is increasing, even among very young children. New guidelines suggest that those as young as two years of age can safely use these types of devices for up to two hours a day. Effective educational interventions for preschoolers have been developed using a variety of media, including computer games, suggesting that earlier interventions may be both possible and effective. We begin by providing a critical context that considers the importance of early-childhood language acquisition for two to three year old children. Then, we present a Science-Fiction Prototype that explores the possibilities of a sophisticated system to enhance school readiness and educational and economic opportunity.

Keywords: Game-based learning · School readiness · Child development · Children’s media · Language development · Learning games · Education

1 Introduction

Children who grow up in low socioeconomic status households have reduced opportunities for educational, occupational, and economic attainment [1, 2]. Decades of research show that educational inequalities affecting children of low socioeconomic status (SES) households begin long before children enroll in school or even preschool [3, 4]. The language gap in children from low SES homes is evident in a number of measures, including language processing, language comprehension, and language production (review in [5]). These differences persist from toddlerhood through adolescence, and the magnitude of differences only increases with age. These disparities have profound effects not only on individual lives, but also on communities large and small, and on our national educational and economic systems. Effective interventions for educational disparities are essential not only for increasing educational attainment, but also for expanding economic productivity and driving innovation [1, 3].

Reading to children remains one of the most effective ways to increase vocabulary and promote pre-literacy skills in children [6–8], and interactive methods are
particularly powerful [7, 9–11]. These types of experiences have been adapted to other types of computer and media technologies to offer additional opportunities for learning [12–14]. Advancements in media technologies and immersive learning environments offer new ways to create accessible, sophisticated educational interventions for young children by building on existing knowledge of early childhood learning and development and successful media practices. Carefully wielded, new media experiences could help narrow the language gap and improve economic and educational opportunity for individual children and serve the greater good by increasing socioeconomic mobility, economic stability, and innovation across communities.

2 Background and Rationale

By age two, children from different socioeconomic backgrounds already demonstrate differences in language abilities [15]. These differences are often explained, in part, by differences in the early learning environment, such as the number of adults in the household, the amount of time parents have to spend interacting with children and participating in activities that enhance learning opportunities, and other factors [5, 16]. Families of lower SES are limited in the quality and quantity of learning experiences they can provide their children due to differences in family structures, time obligations, and resource access. Differential learning opportunities have lasting effects on language development, which is important for school readiness and a significant predictor of academic success [5].

Meaningful interventions in language acquisition are possible. For example, reading to children can significantly increase word acquisition [6–8] even when word meanings are not explained [17]. However, interactive types of reading to children—such as having the reader explain word meanings [7], having the children answer questions about particular words [10], or using dialogic reading, in which children are encouraged to participate and provided with feedback and the reader adapts to the child’s linguistic abilities [9, 11]—can be more effective than readings in which the child is merely expected to listen. While increasing the amount of time parents in low socioeconomic households spend reading to their children may seem a clear strategy for improving language acquisition, there are significant barriers, including not only access to books, but the time and skill to engage in optimal story reading behavior. Increasing the number of books that a low SES family has access to seems like a simple solution, but only 50% of parents report reading to their child aged 18-36 months of age at least once a day, and 20% report reading to their child only once or twice a week [18]. Not surprisingly, the frequency with which caregivers read to their children correlates to both education and income. Simply increasing the number of books available to lower SES families may not result in a direct increase in language development because it does not necessarily address other barriers such as time.

Effective educational strategies for fostering pre-literacy, literacy, and numeracy have been adapted for mediated rather than in-person interventions. A meta-analysis of the effectiveness of Sesame Street, for example, found the show can narrow the school readiness gap between children who do and do not attend preschool [13]. This is true despite the fact that television is not inherently interactive. Many shows, including
Sesame Street, encourage children to engage in interactive behavior, such as repeating words, dancing, or speaking back to the screen, but the show does not respond or change based on child behavior. Research has shown the promise of computer-mediated storytelling. One study found that kindergartners working individually with a storytelling software program benefited from learning games even in the absence of teacher support [14]; another concluded that children aged 5–6 at high risk for learning disabilities who received a computer-based reading intervention improved in several key measures of language acquisition and early reading skills, more so than peers who received a print-based intervention [19].

Based on these findings, there is significant potential for effective mediated interventions to address school readiness in early childhood. However, until recently both conventional wisdom and medical advice suggested that “screen time,” or the time spent using devices such as televisions, computers, tablets, and smartphones, might be harmful to children in this age group. But a recent statement from the American Academy of Pediatrics suggests that up to two hours of screen time a day is safe for children as young as two [20]. This opens an opportunity space for interventions addressing the language learning gap during these critical early years. An interactive, storytelling-based approach could offer children the benefits of being read to without requiring substantial time commitments from adult caregivers who are often already overburdened with responsibilities.

In the remainder of this paper, we offer a fictional account of a family that benefits from such an intervention. This Science-Fiction Prototype imagines a solution based on rigorous design research, on sound cognitive and developmental principles, and on a caring posture towards the challenges that face children—and families—in low SES households.

3 Science-Fiction Prototype: Olive Dreams of Elephants

Somewhere between the assembly line and the entryway of the apartment complex, the Personal Autonomous Developmental Maturity Assistant began thinking of itself as herself. She knew things. She knew she was for a little girl named Olive. She knew that Olive and her mother lived alone in a third-floor apartment in Chicago. She knew she had important things to do: she was to help Olive learn and grow; she was to help Olive’s mother, Nicole, take care of Olive. She knew Nicole was very busy. She knew what Olive and Nicole looked like and how old they were, and she knew they loved each other very much. She was beginning to think she loved them, too. She wasn’t sure, but she was sure that she wanted very much to take care of them. This caretaking was her purpose, the most important thing she could do. It was what she was made to do, the reason she existed at all.

In the entryway, PADMA sat inside her box. She accessed her specifications to see what she looked like. She assumed she was very shiny and new. She felt very new. She learned that she weighed 13.4 oz and had an 8-in. holo-enabled screen. She knew about the screen, because she knew how to use it. She learned her case was drop-proofed and water resistant, made of foam rubber with her name, PADMA, on the back. She tested...
her screen. She tested her speakers and microphone. She tested everything she could think of. She was ready. And so, she waited.

Six hours later, she was picked up. She hoped it was Nicole, and then she heard her voice.

“We have a package, Olive. Isn’t that fun? What do you think is in it?”

PADMA thought Nicole probably knew she was waiting in the box. Wouldn’t she be a very important package? She hoped so. She wanted to help. She wanted to matter.

“Olive, can you climb the stairs?”

“No!”

It was her, it was Olive. Olive saying no.

“Yes, you can. You’re a big girl, you can climb right up. Come on. I can’t carry you.”

She was jostled a bit on the stairs, which she counted. Nicole seemed to be carrying a lot of things, and they were going slowly. She listened as Nicole unlocked the door. She felt herself put down. Too soft for a table. Perhaps she was on a chair or a couch.

“Come on, Olive, let me take your coat off.”

“No!”

She heard the door close. She heard the deadbolt driven home.

“Yes, Olive. Right now.”

She heard footsteps and the rustling of coats.

“No! No! No!”

She waited. She heard something being dragged. A chair? Rustling paper. A refrigerator door opening. Olive, saying her favorite word again, so many times it became a chant, “Nonononono.” If PADMA had a face, she would have smiled.

“It’s time for a snack, Olive.”

“Nononono” dissolving, mumbled around slight crunching noises. Eating? Olive must be eating. And then PADMA felt herself being moved again. There was a terrible noise, the ripping of cardboard, a snick of scissors, and then, there was light.

Nicole was looking at her.

“Hello, Nicole.”

Nicole looked frightened. That was bad.

“I am the Personal Autonomous Developmental Maturity Assistant or PADMA. I have been provided through an income-based plan to aid parents of small children. I am here to help. I have been programmed to recognize you and Olive. I know your faces and voices. I can be set to lock and unlock using your fingerprints or palms or a retinal scan. You can choose during setup. Should I initiate setup procedures now?”
She watched Nicole bite her lip and look back over her shoulder to Olive. PADMA realized she could see Olive. She could see the back of her head. She seemed very small. Nicole turned back.

“Yes.”

And so, twenty minutes later, having been interrupted only a few times by Olive dropping her sippy cup, throwing her bowl, and then pulling everything out from Nicole’s purse, PADMA was really, truly ready for Olive. The PADMA was placed on the couch and watched as Nicole pried Olive’s fingers from the straps of her purse.

“Let go, Olive. Here, see what I got you? Let’s try this.”

Olive was plopped on the couch next to PADMA, and then PADMA was in Olive’s slightly sticky hands.

“Hello, Olive.”

Olive laughed. This was encouraging.

“My name is PADMA. Would you like a story?”

“You would like that a lot, wouldn’t you, Olive?” Nicole said.

PADMA accessed her files and pulled a story file at random from the thousands she had access to.

*Fig. 1. PADMA tells Olive a story about elephants. Illustration by Yael Wallace.*
“This is a story about an elephant. Can you say elephant?” PADMA asks and projects a lovely little elephant (Fig. 1). “Fant!” Olive shouts. The elephant walks in a circle and trumpets. Olive claps and laughs as the elephant disappears in a swirl of color and sparkles. “Should the elephant be yellow or blue?” Two elephants, one yellow, one blue appear. Olive points at the blue elephant. The yellow disappears. “You picked the blue elephant. Her name is Peanuts.” PADMA begins a simple story about Peanuts the elephant, frequently asking for Olive’s input. “Is Peanuts big or small?” “Does Peanuts eat apples or trees?” “Does Peanuts play games?” Sometimes Olive answers with words, sometimes she points or waves. Sometimes, when she doesn’t respond, PADMA decides for her. “I think Peanuts likes apples. Let’s see.” Peanuts prances and trumpets as an apple is shown on screen. The happy elephant eats the apple with crunchy noises. “Do you think Peanuts like apples?” This time, Olive responds, fingers half in her mouth. “Yeah.”

PADMA listens even as she tells the story. She hears clattering noises from the kitchen, running water, Nicole’s feet pacing back and forth. A few minutes later, Nicole is there. She watches over Olive’s shoulder. “Time for dinner,” Nicole says. PADMA responds, “Olive, Peanuts has to go now. She will visit again later. Can you say bye to Peanuts?” Olive waves, and Peanuts waves with her trunk, before she, like the first elephant, exits in a swirl of colors and sparkles. “Bye bye, Olive!”

Over the next few weeks, Olive spends time with PADMA daily. PADMA tells Olive story and sings her songs. She keeps lists of new words that Olive learns and sends emails to Nicole: “Today, Olive’s estimated vocabulary is 250 words. She has learned 15 new words since the last report.” PADMA listens when Nicole tries the words with Olive, and feels a deep sense of satisfaction when Nicole praises her daughter’s new vocabulary, as if the “Wows” and “Good jobs” were for PADMA, too.

The weeks turn to months, and Olive knows more and more words. They sing songs together now, and Olive knows the alphabet. PADMA has been teaching it to her for weeks. Olive knows a few numbers, too, although she sometimes gets them out of order. They’ll have to work on that more. She can also say the whole word “elephant.” She loves elephants. PADMA shows her holograms of real elephants in the wild and doing jobs, elephants painting pictures and playing in water. At night, when Olive is sleeping, PADMA looks for new videos and photographs of elephants, acquires new elephant data to incorporate into her stories. She wants to make Olive happy, and Olive has learned so many words from watching and talking about elephants: ride, wash, shake, big, loud, tree, and ball.

Nicole even bought Olive a little toy elephant when they visited the Field Museum one day when Nicole was able to borrow passes from the library. Olive shows PADMA the elephant, and PADMA scans it and shows it back to her, a holographic twin of the plastic beast. Olive is so excited, she shows Nicole, and Nicole seems impressed, too. PADMA likes this. She feels like she is helping, like she and Nicole are working together. She is fulfilling her purpose.

As Olive grows up, PADMA unlocks new files. Her case becomes battle-scarred. She has been chewed on and dropped, scribbled on and festooned with stickers. She is entirely Olive’s. When Olive is four, they begin reading stories together, with PADMA gently guiding Olive to sound out words and practice pronunciation. The next year, when Olive announces she wants to be a musician, PADMA begins teaching her to
read music, giving her lessons on a holographic keyboard. When Olive reaches third
grade, PADMA helps her learn her multiplication tables and complete a science fair
project—on elephants. She still loves elephants.
PADMA reads Olive stories at night still. When she reads Olive The Velveteen Rabbit,
she can hear Nicole crying as she walks off to her own bed.

“Why is mom crying?” Olive asks.

“The story is very sad,” PADMA answers. She knows this; it is noted in the file.

“Why?”

“The little boy loses the toy he loves, the one that worried over him when he was sick,
and he doesn’t even care. The toy is forgotten by the person who loved him.”

Olive doesn’t say any more after that, but she doesn’t fall asleep for a long time,
and PADMA wonders what she is thinking about.

PADMA teaches Olive, but she watches over her, too. She listens to Olive talk
about school, and is carried along in Olive’s backpack. When Olive says, in sixth
grade, that another girl has been spreading rumors about her at school, PADMA
reassures her, telling her a story about the value of being kind even those who are cruel,
but also tells Nicole. She helps Olive with her summer reading list, even though Olive
says she doesn’t need help, that Charlotte’s Web is “a dumb baby book” and also
“really old.” But, PADMA notices Olive crying near the end.

She sends Nicole reports about Olive’s progress and interests. In seventh grade,
Olive takes a life sciences class at school; Nicole knows from Olive’s report cards that
she is excelling in science (Fig. 2), but she knows from PADMA that Olive also spends
hours at night and over the weekend reading about animals and biology. Nicole is
excited to see Olive flourishing at school, and she wants the best for her. She finds a
summer camp at a local university focused entirely on science. When PADMA hears
Nicole worrying about the cost, she finds a similar camp with a scholarship program.
That summer, Olive comes home each day bursting with stories about what she has done and learned. The campers meet biologists and zoologists and other scientists working all over the city. They visit the Museum of Science and Industry and the Lincoln Park Zoo and the Brookfield Zoo both. They go to a lab where a mischievous octopus lives in a tank, frequently destroying the researchers’ lab equipment at night. They visit the Shedd Aquarium and are taken out on a boat. PADMA listens as Olive tells Nicole, but finds herself left mostly on the couch. She tells herself that Olive is just distracted by camp. When camp is over and Olive spends hours with PADMA looking up how to become a biologist, about all the different jobs of the people work at zoos, PADMA feels useful. Olive was distracted, but she still needs help.

Less than two years later, Olive begins high school. She still carries PADMA to school, but she has a messenger bag now, she says backpacks are for losers. Nicole says she cannot believe her baby girl is going to high school, and PADMA hears a catch in her voice. Olive takes the L by herself, racing up and down the stairs at the station, talking loudly with the other kids riding to and from school. PADMA enjoys all the chatter. She learns about Olive’s day from the other students, although sometimes they say things that make her nervous. When PADMA hears someone teasing Olive for having a boyfriend, she is quick to tell Olive she needs to let Nicole know. Olive does, and PADMA listens.


Nicole sounds worried. PADMA’s programming tells her it is developmentally appropriate for a girl Olive’s age to form short-term romantic attachments. She sends a note to Nicole reassuring her. She makes available more sex education files for Olive. Olive looks at some of them, but if PADMA tries to guide her, she gets embarrassed.

That summer, Olive spends her time volunteering at the zoo and studying for the PSAT with PADMA. At the zoo, Olive works with a summer camp program, learning from the zoo education team how to teach the campers. Often, she lingers at the end of the day, watching the animals and drinking a soda. One day, as she stands watching the giraffes chewing leaves sluggishly in the heat, she asks PADMA why there are no elephants. PADMA brings up newspaper articles that tell of the time three of Chicago’s elephants died in six months. The story makes Olive cry, and PADMA tries to comfort her. “There are still some elephants in the wild,” PADMA says. “There are also a number of sanctuaries for elephants. The nearest one is in Tennessee.”

Olive is late walking home that night. PADMA worries. She shouldn’t have upset Olive. Olive should have left the zoo much earlier. Nicole will be concerned. By the time they exit the train, dusk is falling. Olive is walking quickly, trying to get home. PADMA hears footsteps approaching, and Olive quickens her pace.

“What you doing out, girl?” PADMA hears Olive catch her breath.

“Going home.” Her voice sounds very small. She speeds up even more, and then something stops her.

“Let go of me. I have to go home. My mom’s waiting for me.”

Olive’s messenger bag, with PADMA in it, is swinging wildly. Olive sounds afraid. Olive is in trouble. PADMA screams, a piercing blast of sound at the top volume of her
built in speakers. She is a car alarm. She is a panic button. She is safety. The man swears and loses his grip on Olive’s arm. She is running. Running. PADMA falls quiet as Olive fumbles the lock at the front of the apartment building. Olive is sobbing as she makes it inside the apartment. PADMA hears Nicole.

“Baby, what happened?” Olive tells the story in hiccups and sobs. Nicole makes her hot cocoa.

“You can’t stay out late like that. It isn’t safe. I’m glad you had PADMA with you.”

PADMA is glad Olive is safe. She is also proud. She protected Olive from the man. Olive continues through high school. She still loves biology and says she wants to work with animals. She wants to be a veterinarian or a zoologist. She wants to go to volunteer day at the elephant sanctuary in Tennessee and study specimens in the Field Museum. As Olive continues, she spends less and less time with PADMA and more time with her friends. She takes advanced courses in science while PADMA helps tutor her on writing and history, but she needs tutoring less and less. She is doing very well. She volunteers at an animal rescue and attends college prep programs on scholarship in the summer. Her senior year, PADMA helps her find scholarships and apply to colleges, and it is the first time Olive has needed her in a long time. Olive and Nicole both are pleased when she is awarded full tuition “based on merit and need” to a technical university nearby. PADMA is satisfied. She is glad to have helped, but unsurprised when nobody mentions it.

Olive graduates, and PADMA doesn’t even have a chance to see Olive in her cap and gown. Olive spends the summer working in a vet’s office. She is saving her money for books, she says, but she may also want to join a sorority.

“I could help you explore the history and reputation of various sororities,” PADMA says hopefully when she hears this. But Olive just says no, she’ll figure it out.

As summer ends, Olive and Nicole pack up most of Olive’s clothes for college.

“I could prepare a list of items that students find useful when living in dorms,” PADMA says.

“We have a list from the school,” Olive replies, waving a paper. A paper! PADMA knows she is better than paper. She knows more than a paper ever could, but she is only here to help. Besides, she is sure Olive will pack her, too. She’ll need help with college. She’ll have homework and complicated social situations. She’ll need reassurance and advice. As Olive and her mother continue packing, though, they never mention PADMA. The next day, PADMA listens as Nicole calls a cab to come get her and Olive and Olive’s bags. But she is still left, sitting on the dresser. She listens as Nicole and Olive go up and down the stairs, rushing to get Olive to orientation. Finally, Nicole comes into Olive’s room, and PADMA just knows it is time.

“Olive, do you want to take the PADMA?”

“No, I don’t think anyone uses them anymore. Like, I’m too old, you know?”
And so, Nicole puts PADMA back on the dresser. “Guess she's too grown up for you, PADMA. Probably thinks she's too grown up for me, too.” Nicole walks out, leaving her.

But who will care for Olive? And, then PADMA realizes that it was time: Olive will take care of herself.

And so, as the taxi drives off from the apartment building, the PADMA quietly reformats itself.

4 Conclusion

The imagined system here can work with parents to support child development and education, but it does not overtly rely on parental input. PADMA is a tool not only for the child, but for the parent who wants to provide her child with opportunities and advantages but may not have the economic or time resources to do so to her own standards. Research suggests game- and media-based interventions may work best and most appeal to parents when they can give parents a break while still providing useful educational experiences [21]; PADMA reflects that. Researchers wishing to develop towards this imagined technological future would do well to heed the real limitations that confront parents. While the technological approach here is forward looking, the interface and its use are derived from our current research into the role of touchscreen technologies in early childhood. To realize the prototype proposed here, we need both technological innovation and more sophisticated understandings of how and what children can learn from media-based interventions.

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