Children of the Sun: The Design and Evaluation of an Educational Game about Middle Mississippian Culture

Steffan Byrne, Ball State University
Paul Gestwicki, Ball State University
Ronald Morris, Ball State University

Introduction

"What kind of game is this? Is it asking you questions about Native Americans?" These were the first questions we received as we explained to a group of third-graders that they would be playing an educa- tional game. When we told the student that it was not a quiz-style game, he responded, "It's just like a regular game?" Children as young as eight are familiar with drill-and-practice edutainment software, and this student at least is clearly dubi- ous of them. As educators and scholars, we know that positive learning outcomes can come from "regular games" when their design integrates good practices of game design and the science of learning (*e.g.* Clark and Mayer, 2011; Klopfer et al., 2009). In this paper, we describe the development and evaluation of a game that aligns gameplay and learning objectives—a game designed to promote learning through enjoyable competitive gameplay.

Children of the Sun is an original, educational, tablet-based video game designed to teach about the Middle Missis- sippians—pre-Columbian Native Americans whose culture thrived through the central Mississippi River Valley and surrounding areas around 1000–1500 CE (Pauketat, 2004). Middle Mississippian culture influenced a large geographic area, and *Children of the Sun* is primarily inspired by archaeological findings near Cahokia in modern St. Louis (Pauketat, 2004) and the Angel site in southwestern Indiana (Kellar,

1983). The Mississippians were mound-builders and lived in permanent settlements that ranged in size and com- plexity. Mounds held religious and political significance, and open plazas and community areas were usually sit- uated near the central mounds. Chiefdoms were sometimes surrounded by wooden palisades and were usually located near floodplains and rivers. The size and scale of some chiefdoms have led some scholars to believe that there was substantial oversight and organization as well as social hierarchy in these settlements (Cobb, 2003). The Mississippians grew various crops including maize, beans, and squash— "the three sisters"—and also hunted for food. Many finely crafted artifacts made from shell, bone, stone and ceramic have been found in various sites, sometimes adorned with religious symbols. These artifacts were found far from where they were created, giving evidence to the importance of both trade and gift-giving among Mississippians. However, chiefdoms within Middle Mississipian society also fought each other over land and scarce resources, as well as for ritual or religious pur- poses (Kellar, 1983).

Children of the Sun was designed and developed by a multidisciplinary, primarily-undergraduate team at Ball State University, working in cooperation with The Indiana State Museum. The game was designed for integra- tion with the museum's educational outreach programs on archaeology and Native American culture. The design therefore needed to accommodate an uncommon set of constraints: the game needed to fit into a curriculum for collocated children, engaged in a series of activities on a theme, with only enough time to play the game once. This required the designers to forego common idioms of serious game design based around learning through re- playability and, instead, to draw upon museum exhibit design idioms (Lord and Lord, 2001). That is, although the game would only be played once, it would be framed temporally and spatially by related artifacts and experiences.

Figure 1: Title screen (left) and Naming your chief (right)

Design and Development

The design of the game began in Fall 2012, when a multidisciplinary undergraduate team worked with the Indiana State Museum to develop board and card game prototypes. A committee of scholars and museum staff selected one from among these that could be converted into a digital game: *Mississippia*, a coop- erative, variable-pow- ers resource trading game about life in a Middle Mississippian village (Romelfanger,

2012). A multidisciplinary team of twelve undergraduate students and one graduate student was recruited to produce the game in Spring 2013 as part of a six credit-hour studio course. The team consulted with faculty mentors and museum staff to identify potential learning outcomes for the game based on the results of the paper prototyping and the museum's outreach program curriculum. The following learning outcomes were identified as most desirable: the Middle Mississippians built mounds corresponding to their village's power and status (O1); there were multiple chiefdoms that each lived in their own village (O2); chiefdoms farmed and hunted for food (O3); and chiefdoms competed for resources, sometimes raiding over scarce resources (O4).

Fundamental changes to the original prototype were required in order to meet these objectives and to leverage the affordances of the platform and context of play. The digital game—*Children of the Sun*—is a competitive three- to four-player game of resource management, and it was completed at the end of the Spring 2013 semester. The player takes the role of a chief who delegates his 300 villagers to tasks of hunting, farming, mound-building, and raiding. Hunting and farming generate food, which is steadily consumed by the villagers; without food, villagers will starve and the player's game will end prematurely. Hunting can produce more food fast- er than farming, but hunting grounds are limited; as hunters must travel farther for food, it takes longer for them to return. Raiding can be used to steal food and eliminate opponent's villagers, but it takes time and risks the death of the raiders. The victor is the player whose villagers survive and build the largest ceremonial mound, corresponding to the cultural importance of these mounds to the Middle Mississippians. The primary conflict of the game, then, comes from balancing food production and consumption rates, competing for limited hunting grounds, and investing villagers into the purely ceremonial activity of mound-building.

The game begins with the title screen shown in Figure 1. After each player names his or her chieftain, a still screen explains that the goal of the game is to build the largest ceremonial mound. Then, the player is shown

Figure 2: Village screen (left) and World screen (right)

a birds-eye view of the village (Figure 2), the design of which is based on archaeological maps of the Angel site from Black (1967) as cited in Green and Munson (1978). Villagers assigned to farming or mound-building engage in these activities on the village screen. Tapping the corner of the map brings up the the world map (Figure 2), which shows the distribution of villages. Villages and villagers are color- coded in historically authentic colors of yellow, orange, brown, and blue. Hunting grounds are indicated with deer, wild turkey, and waterfowl tracks. The river provides a natural impediment to villager movement. When villagers are assigned to hunt or raid, they are animated from the village screen to the world map, where they can be seen engaging in these activities. New hunters will seek the closest hunting grounds, moving outward from there if the grounds are occupied, while regular hunters will start by returning to the last hunting grounds at which they were successful.

As raiders leave one village and approach their target, both the attacker's and defender's tablets play an ominous audio track. This sets the mood for the raid and also signals the defender to bring hunters, farmers, and even raiding parties back to the village to protect it. The raid itself is seen on the defender's village screen, which flashes red and plays appropriate sound effects. It is worth noting that raiding does not directly contribute to the game's victory condition—building the biggest ceremonial mound—but it does diminish the target player's ability to hunt, farm, build mounds, or retaliate.

The game features original music and sound effects. Player commands are vocalized with an interpretation of the Middle Mississippian language based on the scholarship of Haas (1956), who conducted fieldwork with the last two living speakers of the Natchez language in the 1930s. This provided the best approximation of what would have been spoken by the Northern Middle Mississippians. The music in the game is based on modern interpretations and re-enactments, which employ quarter-note drum patterns and chanting.

Children of the Sun was developed using an incremental and iterative approach based on the principles of Crystal Clear (Cockburn, 2004) as enacted through Scrum (Keith, 2010; Schwaber and Sutherland,

2013). Physical and digital prototypes were playtested internally as part of each iteration, and later digital prototypes were publicly playtested. *Children of the Sun* was deployed at the museum in Summer 2013, and staff reported it to be an effective intervention as part of the Summer workshops.

Qualitative Evaluation

The successful deployment suggests that the game meets its learning objectives to some extent, but two critical questions remain: what elements contributed to or distracted from these objectives, and perhaps more importantly, what did students learn that was not articulated by the learning objectives? These ques- tions require careful consideration of the lived experience of specific students, respecting the contextual and constructive natures of learning.

To investigate these questions, we developed a qualitative study following Stake (2010), using focus groups and ethnographic methods to gather data. Data collection was conducted in a third-grade classroom at a private school in the midwest. The families at this particular school represent low- to mid-level socioe- conomic status. Eight participants were randomly assigned to two groups of four: both engaged in focus group discussions following a semi-structured interview protocol, but only one of the groups played *Chil- dren of the Sun*. An additional set of post-gameplay questions was used with the latter group. Although the game is designed to take

ten minutes to play, earlier informal evaluations demonstrated that all of the core gameplay could be experienced in less time; the gameplay duration was therefore reduced to five minutes in order to provide more time for discussion. The research data under analysis comprised: field notes from the researchers; approximately forty minutes of video from the two groups; and a memo from the students' teacher, who had been present in the room with the intervention group, though not participating in the study. In addition to the field data, the researchers had access to extensive documentation from the design and development of *Children of the Sun*, including design specifications, prototypes, and meeting notes, all of which were used for triangulation. We note that the goal was not to produce findings that generalize to all possible players, but rather to attempt to deeply understand what impact game elements have on these players.

The data coding process proceeded according to the methods described by Spinuzzi (2003, 2012). His so- cio-cultural research methods are based on activity theory, which describes human activity as being artifact- mediated and oriented toward objectives Vygostky (1978). Activity theory is used in human-computer in- teraction design research (*e.g.* Kaptelenin and Nardi, 2009) and education research (*e.g.* Sannino et al.,

2009). Prior to analysis, the researchers identified five initial codes, representing five expected topics: hunting, raiding, farming, mound-building, and the game's user-interface. Two of the researchers independently proceeded with open coding followed by iterative axial coding—the identification of codes that emerge from the open codes following Saldaña (2012). The researchers met after coding to compare and consolidate their analyses, which were highly congruent.

Findings and Discussion

Through the iterative coding process, we identified three principle themes within these data, drawing upon design documentation and archaeological notes for triangulation. These themes are described and con- textualized in the following subsections. During the discussion, we reference the four players by the pseudonyms Amanda, Andy, Julie, and Mark; the four non-intervention discussants are Alex, Bruce, Chris, and Samantha.

Identification with villages

The players strongly identified with the village and villagers under their control, as one might predict: players identify with pieces over which they have agency in gameplay. The players comfortably referred to the villagers as "theirs" based on the color-coding and the fact that they could be directed to different village actions. When the raiding music began and Mark asked who was being attacked, Andy responded, "Mine! There's bad people outside mine!" Andy did not know who had attacked him, but he interprets them as "bad" because they oppose Andy's own vil- lagers. Perhaps ironically, it was Mark himself who attacked Andy's village, not knowing whose village it was. The designers' intention was for players to recognize each other by color, but the data show that these players were unaware of the mapping.

Although the players immediately showed a sense of ownership and pride in their villages, they also showed little empathy. For example, Mark did not commit enough of his villagers to food-producing actions early in the game, leading his village to starve; yet, his comments show little remorse, except that he could no longer play. That is, he perceived the villagers as an abstract resource. This stands in contrast to the comments from the non-intervention group, who described a chieftain as a merciful role-model who cares about his people.

Clarifying Misconceptions about Native American culture

The non-intervention group exhibited considerable misconceptions about Native Americans, conflating the wide variety of cultures into a composite archetype. Of particular interest to the study was the assumption that all Native Americans lived together in peace. Samantha recalled "a fake bow and arrow" that she and her classmates had seen at a museum during a field trip, leading the group to eagerly discuss how Native Americans cut down trees to make "houses" and "rowboats," as well as "axes" and "saws." When asked what they would fight with these weapons, the group responded with a range of animals, including wolves, wolverines, mountain lions, and eagles. Alex mentioned that they fought "other Indians" at the same time that Bruce suggested "the Pilgrims." Upon further discussion, Alex and Bruce agreed that the Native Americans did not fight each other, though perhaps they "spied" on each other, and also on the Pilgrims. Chris explained, "In a story I heard about Native Americans, some of the pilgrims had guns and they were spying on the Native Americans and going to shoot them, but they ran away before they shot them." The rest of the group appeared to agree with this summation. Unfortunately, we were unable to identify what story, experience, or lesson prompted these classmates to confirm this shared narrative.

The intervention group's post-gameplay responses to the same prompts stand in stark contrast. When asked, "What do you think the Middle Mississippians did?" Amanda suggested that "the Middle Mississippians went over to other people's villages and fought." It is unclear whether her use of the term "Middle Mississippian" reflects real understanding or whether she was simply repeating back the words of the prompt. Mark added that the Middle Mississippians farmed to get "a lot of food," which is a notable comment from a player whose villagers had starved. Amanda added that they hunted and built mounds, demonstrating how the students recognize that actual Middle Mississippians performed the same four activities allowed in the game. However, these were also the only four activities that the students offered in answer to the prompt. The study was conducted in a school, and in this setting, the students may have seen these as the expected and therefore correct answers.

The intervention group did not mention Europeans during gameplay or in the discussion, and so we do not know how or whether this experience integrated with their prior understanding. However, it is safe to assume they approached the game with the same misconceptions as the non-intervention group, as they were randomly selected from the same class.

Children of the Sun lacks non-violent, non-competitive interactions between players, and it appears this contributes to players' inaccurate understanding that all inter-village interactions were violent or competitive. The design team had planned to include peaceful village interaction options into the game, particularly relating to trade, reciprocal gift-giving, and *chunkee*—an important Native American sport. However, production constraints led to these features' being cut. Playtesters enjoyed raiding, which encouraged the development team to invest even more effort into this feature: raiding had more custom animation, villager behavior, and custom audio than any other game feature. This positive feedback loop between developers and playtesters seems to have caused to the players to mischaracterize the inter-village relationships of the Middle Mississippians.

Collocated play and interface barriers

The study demonstrated how peer learning and collocation allowed players to overcome interface design defects. This point can be illustrated with four short vignettes. To start the game, Julie created a game that the other four had to join. Mark had trouble figuring out how to connect to the game, and so she scooted over to help him. Later, some of the players had difficulty interpreting the interface tutorial, but when Andy exasperatedly admitted, "I'm not getting this," Amanda was able to show him what to do. When Mark looked over the village screen, he asked, "How do I attack?" Julie searched her screen for such an option, but not finding it, asked "What's 'Raid'?'. Mark clarified that this word meant "attack," and both were able to use this feature. Finally, during the game, Andy narrated, "I'm bringing my people back." Amanda and Mark simultaneously asked in reply, "How do you bring your people back?" Andy explained, and after trying it, Amanda confidently responded, "Oh, I know how to do it."

There was almost no discussion of mound-building during play. Indeed, Amanda was surprised to find out that she won the game. She had been the only one who acknowledged seeing the game's brief explanation of the victory conditions—the others disregarded the text in their eagerness to get into the gameplay. The game designers intentionally omitted an in-game leaderboard so as to encourage players to keep tabs on each others' villages in their shared physical space. However, without understanding that there was something to monitor—namely, the size of the central ceremonial mound—the students showed no interest in watching each others' screens. During the post-game discussion, after being reminded that it was the size of the mound that determined victory, Andy asked, "But what about the raid and the hunt and all that?" After clarifying that this was for food, Andy realized, "If you don't get food, you don't live, and you can't build the mound." Amanda expressed pride in winning for having built the mound, but there is no evidence that this was an intentional strategy during gameplay. In her own words, her strategy was, "I moved people around. I moved some to go hunt and some to the raid, and then I moved some to plant and grow crops. And then I moved some to build the mound. And then I took some from the mound to the crops."

None of the players discovered that they could switch between the village and world map screens. The animations had been designed to encourage the player to follow outbound villagers to the world map screen, but nothing in the game design explicitly calls the players' attention to this. In the absence of a perceived affordance, the player could learn nothing about it (Gibson and Pick, 2003; Linderoth, 2010).

This discussion needs to be contextualized within the unconventional design constraints of the game. Outside of the study, players would only be able to play this game as part of a larger museum experience involving artifacts, lessons, and discussions, the gameplay itself mediated by museum educators. The formal evaluation was unable to use this context, but just as the school context influenced our subjects, the museum context surely influences those who play the game within its intended environment.

Conclusions

Children of the Sun teaches fundamentals of Middle Mississippian culture by placing the player in the role of a chief. We find that players—in both informal playtesting and formal evaluation scenarios—were able to clearly articulate facts about the Middle Mississippians based on their gameplay experiences. The game meets the learning objectives for which it was designed, validating a development approach that included two semesters of multidisciplinary, primarily-undergraduate teams. Although *Children of the Sun* meets the needs of the client and the learning objectives of the designers, the scholarly evaluation reveals more inter- esting relationships between player experience and learning. What players learned was directly related to their gameplay experiences, but pre-ordained measurable learning outcomes cannot account for the back- ground knowledge that a user brings to the play experience. We find that, regardless of whether the play experience supported a learning objective, each play experience can be traced back to a design decision made by the development team. This reinforces the need for great care in designing gameplay around learning objectives Klopfer et al. (2009); furthermore, this exemplifies the need for evaluation of educational games to consider perspectives much broader than the articulated learning objectives. Recognizing the constructive nature of learning requires an evaluator to consider what students learned that is not within the learning objectives.

Acknowledgments

References

Black, G. A. (1967).*Angel Site: An archaeological, historical, and ethnological Study*. Indiana Historical Society.

Clark, R. C. and Mayer, R. E. (2011). *E-Learning and the Science of Instruction: Proven Guidelines for Con- sumers and Designers of Multimedia Learning*. Pfeiffer, third edition.

Cobb, C. R. (2003). Mississippian chiefdoms: How complex? *Annual Review of Anthropology*, 32. Cockburn, A. (2004). *Crystal Clear: A Human-Powered Methodology for Small Teams*. Addison-Wesley. Gibson, E. J. and Pick, A. D. (2003). *An ecological approach to perceptual learning and development*. Oxford University Press, Oxford, UK.

Green, T. J. and Munson, C. A. (1978). Mississippian settlement patterns in southwestern indiana. In Smith, B. D., editor, *Mississippian Settlement Patterns*, pages 293–330. Academic Press.

Haas, M. R. (1956). Natchez and the Muskogean languages. *Language*, 32(1):61–72.

Kaptelenin, V. and Nardi, B. A. (2009). *Acting with Technology: Activity Theory and Interaction Design*. MIT Press.

Keith, C. (2010). *Agile Game Development with Scrum*. Addison-Wesley.

Kellar, J. H. (1983). *An introduction to the prehistory of Indiana*. Indiana Historical Society. Retreived from http://www.gbl.indiana.edu/abstracts/IHS/ktoca.html.

Klopfer, E., Osterweil, S., and Salen, K. (2009). Moving learning games forward: Obstacles, opportunities, & openness. Technical report, The Education Arcade, MIT. Retrieved from http://education. mit.edu/papers/MovingLearningGamesForward_EdArcade.pdf.

Koster, R. (2013). *A Theory of Fun for Game Design*. O'Reilly Media, second edition.

Linderoth, J. (2010). Why gamers don't learn more. an ecological approach to games as learning environ- ments. In Petri, L., Mette, T. A., Harko, V., and Annika, W., editors, *Proceedings of DiGRA Nordic 2010: Experi- encing Games: Games, Play, and Players*, Stockholm. University of Stockholm.

Lord, B. and Lord, G. D., editors (2001). *The Manual of Museum Exhibitions*. Altamira Press, Lanham, MD.

Pauketat, T. R. (2004). *Ancient Cahokia and the Mississippians*. Cambridge University Press.

Romelfanger, J. (2012). Mississippia. Board game (unpublished).

Saldaña, J. (2012). *The coding manual for qualitative researchers*. Sage Publications, Thousand Oaks, CA, second edition.

Sannino, A., Daniels, H., and Gutiérrez, K. D., editors (2009). *Learning and Expanding with Activity Theory*. Cambridge University Press.

Schwaber, K. and Sutherland, J. (2013). *The Scrum Guide*. Scrum.org, July 2013 edition.

Spinuzzi, C. (2003). *Tracing Genres through Organizations: A Sociocultural Approach to Information De- sign*. MIT Press.

Spinuzzi, C. (2012). *Topsight: A Guide to studying, diagnosing, and fixing information flow in organizations*. CreateSpace.

Stake, R. E. (2010). *Qualitative Research: Studying How Things Work*. The Guilford Press.

Vygostky, L. S. (1978). Interaction between learning and development. *Readings on the development of children*, pages 34–41.