Engaging in Game-Based Family Discussions to Promote Science Inquiry

Objectives:

The purpose of the study is to examine the opportunities for family discussions about science that are presented in the "Family Science App," a multiplayer, educational game for iOS and Android developed by Twin Cities PBS, a nationally-recognized public media producer. Funded by the USDOE RTL, the "Family Science App" is part of a larger transmedia suite of educational media content related to an upcoming science television show. The goal of the RTL grant is to provide opportunities for science learning across diverse families (e.g., ELL, low-income, Latino, children with special needs). Within the game, players are asked to conduct investigations together in order to determine the identity of an unknown item (e.g., animal, food) using science and engineering practices aligned to the K-2nd grade Next Generation Science Standards (NGSS). K-2nd grade children and their families can choose from a selection of "superhero powers" that allow them to discover characteristics about the unknown item (e.g., the superhero power of "Speedometer" tells the player how fast the animal can move). Families must work together to uncover characteristics about the item and use scientific inquiry and discussion to analyze their clues and determine the identity of the item.

The current pilot study explores the types of scientific discussion fostered during gameplay and any trends in play patterns across age groups and family groups. Data from a forthcoming implementation study will be conducted using an expanded version of the game and will further explore the types of science discussion that families engage in during gameplay. The research questions that guided the pilot study were: 1) What type of discussion occurs during gameplay?; 2) Who participated in discussion during gameplay?; and 3) What trends in play patterns were observed across age groups and family groups?

A future implementation study will further explore the types of discussion generated through gameplay. The implementation study will be completed shortly, and the results will be incorporated into the final version of this paper.

Theoretical Framework:

In light of increasing interest in digital media resources, researchers have investigated the effects of learning media on students, and there is growing evidence that digital games can contribute to student learning (Squire, K., Barnett, M., Grant, J. M., & Higginbotham, T., 2004, Hsu, Tsai, & Liang, 2011; Huang, 2011; Tobias, Fletcher, Dai, & Wind, 2011; Wang & Chen, 2010, Dunbar, Norah E. et al., 2013). In addition, a growing body of research suggests that educational digital games confer additional advantages to students by supporting the development of 21st century skills, such as collaboration and critical thinking (Shaffer, D. W., Squire, K. R., Halverson, R., & Gee, J. P., 2005, McCreery, Schrader, & Krach, 2011; Miller, 2012).

Additional research has also shown that involving families in their children's education, particularly when the child is at an early age, can positively influence a child's performance in school and beyond (Becker & Epstein, 1982; Fan & Chen, 2001). In particular, research suggests that collaboration between students and adults, as well as with peers, during technology use is beneficial to student learning (Heft and Swaminathan, 2002; NAEYC and FRC, 2012; Zur, 2015).

Taken together, these studies suggest that digital games fostering student collaboration with both peers and adults confers advantages that may be beneficial to student learning. These advantages include increasing family engagement in students' learning and promoting opportunities for students to engage both peers and adults in academic content outside of school.

Methods:

The pilot study used a qualitative design to examine the types of scientific discussion occurring between family members during use of the "Family Science App," and whether evidence of any trends existed across family groups around engagement and gameplay patterns.

Nine family groups, which consisted of 10 adults and 21 children in total, participated in individual 30-minute play sessions. All family groups included a child in the targeted grade range of K-2. Family groups also included older siblings, other family members in the targeted grade range, and other adult family members. See Table 1 for participant group configurations.

During each session, each family group engaged in multiple rounds of play within the app. To allow players to engage with the app in a naturalistic manner, families used the app without facilitation or assistance from researchers during the first round. Researchers then encouraged players to play the app for a second round, in which researchers provided facilitation assistance if the family experienced difficulties with parts of the game or if little discussion occurred in the first round. Families were then given the option of playing a third round, where researchers continued to provide assistance depending on the level of discussion and inquiry observed.

Data Sources:

Researchers observed the sessions and collected data using a detailed *observation protocol* that captured quotes from family discussions, noted when discussion occurred during gameplay, and recorded which family members were actively involved in gameplay and discussion. Families participated in a *post-interview* at the end of the testing session. Families were asked to describe their general reactions to the app and their understanding of the scientific content presented during gameplay.

Qualitative data from across the nine sessions was analyzed using grounded theory, or constant comparative analysis (Strauss & Corbin, 1998). In an initial data reduction approach, observation data were reviewed and assigned categories of meaning using established methods for coding qualitative data (Miles & Huberman, 1994). Identified categories were then further reduced to produce study findings.

Results:

Analysis of the qualitative data from the pilot study suggest that family groups of different sizes and configurations could successfully play the game with little outside support. Findings related to each research question are presented below.

1) What type of discussion occurs during gameplay?

Analyses conducted of the observation data suggest that the game provided families with opportunities for discussion that engaged in selected Science and Engineering Practices (SEPs) outlined in the NGSS. Though some sessions afforded more opportunities for families to engage in science inquiry, all nine family groups were observed to engage in some science discussion during gameplay, and very little off-task discussion was observed. Table 2 presents the alignment between the app's targeted SEPs and player actions in the game. Participating family members would spend much, if not most, of their discussion interpreting the provided clues to determine the animal inside the box. Both adults and children commented on the clues as they were received, and most family groups engaged in analysis of their clues at the review screen, after all of the clues had been received. A few family groups interpreted their findings as the clues were being given and would synthesize their new information with previous clues to refine their guesses.

The observation data from this study will be used to create a protocol and coding scheme for the planned implementation study. Data will be analyzed in order to determine categories of questions and remarks made during gameplay by both children and adults, and these categories will be incorporated into protocols for the study, allowing researchers to quantify the types of discussion that occurs during gameplay.

2) Who participated in discussion during gameplay?

As a whole, both adults and children were observed to participate in discussion during gameplay. Adults tended to function as guides during gameplay by either facilitating discussion or offering encouragement. Adults often read the words on the screen aloud to children, thereby guiding the gameplay without directly taking action in the app. In a few instances, the adult player would guide children to review the clues prior to making an animal selection. The adult players also tried to make sure that all players saw and understood the clues provided in the game. For example, adults would ask children what they thought, what they noticed and saw, what clues they observed, and what those clues meant ("What's light like a feather?" or "What's heavier out of a golden eagle and a brown bear? What's heavier out of a golden eagle and an anaconda?"). Adults also provided strategies, such as process of elimination, for children to determine which animal matched all the clues. Similarly, one adult decomposed the larger task into more manageable sub-tasks, by asking the children to think about two animals at a time and to think about which animal of the two better matches the clue. Lastly, adults also guided turn taking among players. They noticed who spoke more or less during the game and encouraged players to contribute equally. Research in the implementation study will further examine which players participate in discussion and how to better scaffold science inquiry and conversation between players during gameplay.

3) What trends in play patterns were observed across age groups and family groups?

Researchers observed that the amount of conversation and structure of discussion varied depending on the composition of the family group. Researchers observed that sessions with one child and one adult engaged in less discussion in comparison to family groups comprised of two children or multiple children. In general, researchers observed that children participating in one-on-one sessions did not initiate discussion and did not offer as many opportunities for discussion.

Researchers observed that discussion during one-on-one sessions was most often initiated by parents who prompted their children to voice their thoughts.

In groups with multiple children, it was noted that younger players were often quieter than their older siblings, and parents would actively encourage and draw the younger or quieter players into the conversation. In some cases where the younger child struggled with gameplay, the older child would take over and complete the action or provide the answer for the younger child, rather than supporting them to complete the action themselves. In other cases, the parent and older child talked about the content in a more sophisticated way that was not easily accessible by the younger child. However, this was not from a lack of interest by the younger children, who were often observed to make comments and ask questions in attempts to include themselves in the gameplay and discussion. Yet, these attempts were not given equal weight in the discussion.
In larger family groups, researchers observed more players talking over one another and generally less structured conversations. Research in the implementation study will continue to examine trends across age groups and family groups

Both adults and children were engaged with the gameplay during sessions, though not all participants were equally. The level of engagement in players was noted to change over time with the number of rounds played, as children would lose interest after several rounds of play. However, all family groups played multiple rounds of the game, and the observations noted that discussion centered almost exclusively on the gameplay.

Analysis of post-interviews suggested that participants enjoyed the game because of its ease of use and its embedded content. Many children enjoyed the gameplay elements of selecting their own characters and enjoyed predicting and solving the challenges posed to them within the game. Participants also appreciated that the game promoted collaboration. Participants provided suggestions for improvement to the game content and design to increase engagement and gameplay complexity.

Significance:
In addition to contributing to the further development of a game that supports student engagement in science at home, this study contributes to the growing body of research that suggests digital learning environments can promote collaboration among peers and with adults for deep engagement in student learning (Hanna & Richards, 2012). The current pilot study indicates that digital media such as the "Family Science App" show potential in facilitating science and engineering practices outside of formal school environments. In addition, findings from this study indicate that the game is feasible for use among a variety of family configurations and promotes collaborative discussion among adults, children, and peers. Results of the current study suggest that the "Family Science App" could be further refined to support family engagement in science practices, and additional testing with diverse family groups should occur when developing home-based interventions.

Table 1. Participant Demographics for Family Groups

Family Group	Participant	Grade	Gender
1	Parent	N/A	Male
	Child	2nd	Male

2	Parent Child	N/A Kindergarten	Female Male
3	Parent Child Child (Joined at end of session)	N/A 1st 3rd	Female Female Female
4	Parent Child Child	N/A 1st 3rd	Female Male Female
5	Parent Child Child	N/A 1st 3rd	Female Female Female
6	Parent Grandparent Child Child	N/A N/A Kindergarten 3rd	Female Female Male Female
7	Parent Child Child Child	n/a 1st 2nd 3rd	Female Male Female Female
8	Parent Child Child Child	N/A Kindergarten 1st 2nd	Male Female Male Male
9	Parent Child Child Child Child	N/A Kindergarten 1st 3rd 5th	Male Male Male Female Male

Table 2. Alignment of the Family Science App to Science and Engineering Practices.

NGSS SEPs	Alignment with the Family Science App
Asking questions (for science) and defining problems (for engineering)	The players must ask each other questions about why a certain finding suggests that it is a certain animal.
Planning and carrying out investigations	Players must choose which heroes and tests they will use to gather information about the item in the box.

Analyzing and interpreting data	Players must interpret the findings from their tests to make an informed decision about which item is in the box.
Engaging in argument from evidence	Often times, players disagree about what item is in the box based on the findings from their tests. In order to come to a group decision, players must engage in arguments based on evidence to convince their teammates of their position.

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