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Rule the Roost

Designing a Game That Builds STEM Identity for Girls

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Abstract

A strong STEM identity is crucial to both choosing and persisting through STEM careers. This is especially true for women and young girls, who face additional barriers including common misconceptions and a lack of role models. *SciGirls* is a transmedia initiative that addresses these barriers by engaging tween girls with STEM experiences and changing their perceptions of STEM. *Rule the Roost* is an online game that promotes the development of a strong, positive STEM identity through the integration of *SciGirls* gender equitable strategies, citizen science, and creative game design. Elements of alternate reality gaming and self-directed learning engage players in completing real world projects that develop STEM and 21st century skills. These skills, connected to game skills and experience points, are reflected as part of an online profile defining the player's STEM identity, which can ultimately transfer to her personal identity.

Science for Girls

The mission of *SciGirls* – changing how millions of girls think about science, technology, engineering, and math (STEM) – addresses barriers to STEM that include a lack of identity (girls' perception of themselves as scientists or engineers), low self-esteem resulting from stereotypes around girls' lack of ability and interest, and limited exposure to female role models in STEM. To help girls emerge from the challenging tween years with a positive attitude towards STEM, *SciGirls* provides meaningful experiences through a robust, three-pronged transmedia effort that includes television, outreach, and online experiences. Underlying this effort are research-based strategies and a SciGirl "identity" that together lay the foundation for a unique and powerful game: *Rule the Roost*.

The Importance of Identity

During the middle school years, girls are developing their own interests and recognizing their academic strengths. Unfortunately, by the end of these crucial tween years, many girls do not think of themselves as smart or capable enough to engage in STEM. Several researchers point to "identity" as one of the main barriers to girls' perceptions of themselves as scientists (Eccles, 2011; Fenichel & Schweingruber, 2010). Identity is a powerful construct to address the STEM barriers facing young girls because it integrates self-concept, sense of agency, content confidence, personal relevance, interest and motivation. The freedom to fashion identities in play is an important affordance of games (Klopfer, Osterweil, &

Salen, 2009). While experimenting with different identities and practicing various behaviors players are defining themselves, and by providing STEM-influenced identities to play with, *Rule the Roost* creates the opportunity for a STEM identity to be a part of that definition of self.

The *SciGirls Seven*

At the core of *SciGirls* is The *SciGirls Seven* (see Table 1), a set of research-based strategies proven to increase girls' interest in STEM and improve their attitudes towards STEM (Flagg 2010, 2012). These strategies encourage collaborative, meaningful, creative, and open-ended activities; promote a growth mindset and critical thinking; and emphasize the use of female STEM role models – all of which are crucial to addressing the specific barriers preventing girls from choosing STEM.

1	Girls benefit from collaboration, especially when they can participate and communicate fairly. *(Parker & Rennie, 2002; Scantlebury & Baker, 2007; Werner & Denner, 2009).* Highlight the social part of science - working and learning together. Create a community atmosphere that encourages girls to share their ideas and value each contribution.
2	Girls are motivated by projects they find personally relevant and meaningful. *(Liston, Peterson, & Ragan, 2008; Lyon & Jafri, 2010; Mostache et al, 2013; Patrick, Mantzicopoulos & Samarapungavan, 2009; Thompson & Windschitl, 2005).* Motivate girls with projects that are important and can make a difference. Use STEM as a tool to explore topics that girls can connect to with similar situations from their own lives.
3	Girls enjoy hands-on, open-ended projects and investigations. *(Chatman et al., 2008; Denner & Werner, 2007).* Promote exploration, imagination, and invention by encouraging girls to ask questions and find their own approach to projects. Focus on the "why" and "how" over finding a "right" answer.
4	Girls are motivated when they can approach projects in their own way, applying their creativity, unique talents, and preferred learning styles. *(Calabrese Barton et al., 2013; Calabrese Barton, Tan, & Rivet, 2008; Eisenhart & Finkel, 1998; Lyon & Jafri, 2010).* Give girls ownership of every step of the process including designing their approach, collecting data, and communicating results. Encourage girls to develop their own ways of exploring and sharing knowledge.
5	Girls' confidence and performance improves in response to specific, positive feedback on things they can control—such as effort, strategies, and behaviors. *(Blackwell, Trzesniewski & Dweck, 2007; Dweck, 2000; Halpern et al., 2007; Kim et al., 2007; Mueller & Dweck, 1998).* Allow girls to fail or struggle and emphasize that their skills can be improved with practice. Share individual ideas, knowledge and accomplishments with the group.
6	Girls gain confidence and trust in their own reasoning when encouraged to think critically. *(Chatman et al., 2008; Eisenhart & Finkel, 1998; Kim et al., 2007).* Lead girls to ask questions and think creatively. Focus on the problem, consider different approaches and solutions, and re-examine ideas.
7	Girls benefit from relationships with role models and mentors. *(Holmes, Redmond, Thomas & High, 2012; Liston, Peterson & Ragan, 2008; Lyon & Jafri, 2010; Mostache et al., 2013; Weber, 2011).* Leverage role models to demonstrate how girls can succeed in STEM and inspire girls to pursue STEM. Include stories that allow girls to relate to role models and mentors as real people who are more than just their careers.

Table 1. The SciGirls Seven.

The *SciGirls Seven* foster collaboration, communication, creativity and critical thinking – all tools for STEM success and positive STEM identity building. STEM experiences that allow girls to apply

their own creativity and individual approaches encourage girls to develop a sense of agency and confidence in STEM content. Meaningful, interest driven, and personally relevant projects motivate girls to make stronger connections between their personal identity and their STEM identity. Emphasis on a growth mindset further promotes confidence and builds the resilience girls need to persevere and overcome barriers. Finally, exposure to female role models that challenge stereotypes reveals to girls that engagement with STEM and a STEM identity can be both possible and positive.

The SciGirl Identity

The above strategies, and their connections to STEM identity, became the foundation for a redesigned *SciGirls* website and new games. The approach sought to create a 'SciGirl' identity that defines qualities needed to succeed in STEM (see Table 2). An initial need to create a better experience for user profiles and user-generated projects evolved into an integrated game-profile experience that features, promotes, and celebrates each SciGirl. Further reflection revealed that many of these qualities and values were already visible throughout *SciGirls* media and resources in storytelling, content, and design. While developing *Rule the Roost*, the SciGirl identity was heavily leveraged to create an experience that builds a sense of community and collaboration, an interest in meaningful and relevant topics, and a culture of self-direction and asking questions.

Who is a SciGirl?	**The *SciGirls Seven***
SciGirls work together.	Girls benefit from collaboration, especially when they can participate and communicate fairly.
SciGirls make a difference.	Girls are motivated by projects they find personally relevant and meaningful.
SciGirls ask questions and explore.	Girls enjoy hands-on, open-ended projects and investigations.
	Girls gain confidence and trust in their own reasoning when encouraged to think critically.
SciGirls aren't afraid to make mistakes.	Girls' confidence and performance improves in response to specific feedback.
SciGirls are creative and unique.	Girls are motivated when they can approach projects in their own way.
SciGirls motivate others.	Girls benefit from relationships with role models and mentors.

Table 2. Who is SciGirl?

Citizen Science

In addition to promoting STEM identity, goals for the new *SciGirls* games included addressing the topic of citizen science, or participatory science, in a meaningful way by conveying key concepts, motivating girls to participate, and educating girls about research protocols. Based on research on the personal and social factors that motivate participants to engage in citizen science (Dickinson & Bonney, 2012), several factors became part of the design of *Rule the Roost* (see Table 3). In many ways, the key points are already connected to The *SciGirls Seven* and the SciGirl identity through the collaborative, hands-

on, relevant, and meaningful nature of citizen science. Gameplay incorporates the motivators for citizen science by rewarding participation, encouraging productivity, presenting a variety of interests, and engaging players as a community. The collaborative effort and real world focus of citizen science also overlapped with similar qualities of alternate reality games including the idea of a collective intelligence created through both an online world and the real world. This combination of online and offline play inspired the next evolution of transmedia techniques already integrated within the *SciGirls* approach.

Key Citizen Science Concepts
Collaborative in nature
Anyone can participate
Includes a protocol and requires observation skills
Contributions are compiled and used by researchers

Motivators for Citizen Scientists
Perceived personal benefits
Satisfaction of being productive
Alignment with personal interests
Social interaction and community collaboration

Table 3. Integrating Citizen Science.

Rule the Roost

From the unique connections between STEM identity and SciGirl identity, citizen science concepts and motivators, and elements of alternate reality gaming, the innovative features for the online, session-based, persistent game *Rule the Roost* were born. Players participate in both online and offline play on randomly assigned teams for both collaborative research challenges and self-directed projects. In each month long game session, *Rule the Roost* presents a "Big Question" that all players can help answer by following a simple protocol to collect and submit data. Players can review all the submitted data from the entire community in live, age-appropriate visualizations. Additionally a selection of open-ended "Questies" that vary from session to session is also available for players to complete, submitting details and photos for points. Throughout each session, players can view submitted photos and "Roost Stats" that include current team scores and recent activity by other players. While playing *Rule the Roost*, players are also building persistent profiles that showcase the accomplishments and skills they have accumulated across all sessions.

The Big Question

To present the Big Question, a homemade, DIY style video employs peer modeling by starring real girls who are thinking about science through meaningful topics (like nature, sleep, and weather) that are relevant to girls' everyday lives. These diverse, curious, and confident girls introduce a question about a topic they are interested in (like whether different combinations of activities affect their ability to multitask) and ask for help from the entire community of players to answer. Similar to formal citizen science projects, the Big Question has a simple protocol for observation and collection of real world data that is outlined for players to follow. All the submitted data, including their own, is compiled together for players to view in the form of simple graphs that grow in real time as player data from all over the country is submitted. In this way, girls can see that citizen science is collaborative, all submitted data becomes part of a large collection, and their contribution is important. Anyone can participate in citizen science and any player can participate in the Big Question.

Questies

Questies are real world, open-ended projects infused with STEM and 21st century skills. These projects have a low point of entry with little to no material cost; are engaging, accessible, and relevant to girls' every day lives; and cover a variety of topics and interests including nature, technology, health, community and more. Players choose which Questies to complete and can complete as few or as many as they like within the available list. In this way, players are given agency to direct their efforts, exploring and developing their own interests and motivations. When selecting a Questie, players can read a brief description and, after selection, complete the project away from the online part of the game, having an authentic real world experience. Upon completion of the project, players return to the online game to answer a few simple multiple-choice questions and submit photos.

In Questies, STEM topics and 21st century skills overlap often so that girls can discover new interests by seeing connections to existing interests. For example, a girl who is interested in creating videos but has no interest in physics may show an interest in physics after creating a video to capture a levitating slinky in slow motion (the "Floating Slinky" Questie). And because people are more likely to participate in citizen science projects when they align with their own interests (Dickinson & Bonney, 2012) giving girls exposure and opportunity to engage with new interests increases their likelihood to participate in one of the variety of citizen science projects that exist. Many Questie topics also incorporate small-scale philanthropy like organizing a children's book drive, making a school map for new students, or creating a PSA about recycling. Through completing Questies, girls can not only build interest and experience with STEM but can also see STEM as a tool for improving their own lives and the lives of others.

Questies provide starters for interest-driven, open-ended projects through a combination of descriptions that give the least amount of instruction needed and multiple-choice questions that reinforce project goals, provide opportunity for reflection, and/or add context and structure to the experience. For example, the Questie "Wing It" gives players a project goal of creating different paper airplane designs to test and compare (Figure 1). Players take ownership of the process, applying their own creativity to how they design the paper airplanes, how they test the designs, and what attributes or results they compare. There is freedom of effort in both how many designs or tests players attempt and how elaborate the designs and tests are. The multiple-choice questions reinforce comparison of the designs as part of the goal by drawing attention to speed, distance, and parts of the airplane. While the multiple choice questions require an answer and only one photo may be uploaded, the focus isn't on giving a single "right answer" but rather on the experience itself: the player's approach, communication of results, or opportunities for critical thinking. Players are rewarded for their efforts (regardless of their outcome, ability, or approach) with points earned for their team and experience points earned for the corresponding skill in their personal profiles.

Figure 1. Screenshot of Questie.

Roost Stats

At the end of each month-long session of *Rule the Roost*, the team that has earned the most points is declared the ruler of the roost. A "homepage takeover" of the kids' website features the winning mascot (one of four birds, each with their own girl-friendly and STEM/SciGirl inspired identity of being fierce, playful, clever, or heroic) until the next team triumphs. During a session, players can view live "Roost Stats" that create and reinforce a sense of community among players through a "newsfeed" of the most recent player activity, a list of popular Questies, and the session's top players. In this way, the accomplishments of players in both an individual and team context are shared with the player base, allowing girls to find other players' profiles to view and even "give a hoot" of approval for all to see.

Profiles

Profiles are customizable and unique to each player (see Figure 2). A player's profile showcases all her in game activity (across all sessions), her mastery of each skill (labeled with identifiers such as "Builder", "Designer", "Tech Whiz" etc.), photos of her projects, her current team, and the identifier she has chosen for her "role" in the team (writer, artist, explorer, etc.). The most visible and interesting content in a profile are accomplished in the real world as part of the game (rather than creating an avatar or decorating a room), so a girl can see that it is her interests, knowledge, skills, and actions (who she is) that is important – not appearance or stereotypes. And because her own interests and choices decide everything she does within the game, both online and offline, her profile is a reflection of a part of her real self.

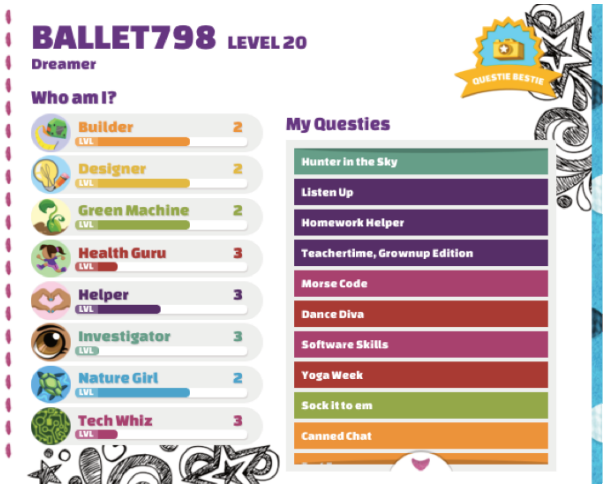

Figure 2. Screenshot of player profile.

Post Mortem

The design and development of *Rule the Roost* involved finding connections between the identity of *SciGirls* and citizen science content to give girls the opportunity to identify with STEM. Ultimately, this meant creating both a new approach and a new kind of experience. Players' efforts and experiences are uniquely influenced by their own imagination and context. This is most visible in the photos that players submit which showcase a variety of individual results. For example, most photo submissions for the Questie "Wing It" are simple images of the paper airplanes themselves. However, one player submitted a photo of the data from her test flights, detailing the performance of her airplanes in tables for comparison. Another player showcased each airplane with labels for which flew fastest or furthest. And yet another player showed her airplanes with sketches of each flight pattern and whether she considered the designs successful based on how long they stayed in the air. Looking at player profiles, there are casual players with a few projects and a short Questie history, but also hardcore players who have scored at the top for multiple sessions and have well over a hundred completed Questies. Many girls complete projects within each skill area while some girls focus attention on a few skills, often including "Investigator" which is leveled by completing the citizen science activity the Big Question. Thousands of girls have played *Rule the Roost*, developing their in-game STEM identities through the thoughtfully and creatively designed online and offline play. Because those identities are built from real world play that is influenced by their existing identities, they are likely to integrate into girls' personal identities.

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