Using Games to Solve Real-World Civic Problems: Early Insights and Design Principles

Karen Schrier
Marist College

ABSTRACT

Video games are starting to be used to support civic learning and engagement. Moreover, games are being used to crowdsource solutions to real-world problems; however, few of these games address civic problems and engage adolescents and young adults. In this paper, I explore designing and using games for real-world civic problem-solving, as well as for supporting civic engagement among young adults. Using a design analysis approach, I investigate six video games and propose 20 initial design elements for use in creating and implementing civic problem-solving games. These include principles such as: using authentic civic problems, data, and tools; enabling the comparison and verification of solutions to civic problems; and facilitating interaction with multiple civic-related solutions, perspectives, and roles.

Keywords: civic engagement, civic learning, crowdsourcing, community engagement, videogames

INTRODUCTION

Adolescents and young adults are considered to be the least civically engaged populations, possibly because they feel they cannot meaningfully impact the political process or because they believe that the political sphere is disconnected from their interests and ideals (Syvertsen, et al., 2011; Torney-Purta, Richardson, & Barber, 2004). Moreover, there is a "civic divide" in terms of which adolescents and young adults participate in elections or in their communities, in that those with more education and those who come from more financially stable families are also more likely to have opportunities for and encouragement toward civic participation (Verba, Burns, & Schlozman, 2003). In general, however, college students and other young adults have lower voting rates than other demographics. For instance, according to CIRCLE (Center for Information & Research on Civic Learning & Engagement), around 50% of youth ages 18-29 voted in the 2016 U.S. Presidential election (Circle, 2016). Moreover, youth aged 18-20 years old commonly have the lowest turnout of any age for elections for public office (Hall, 2008; Niemi & Hanmer, 2010), as well as less participation in civic meetings or town hall events, and may not be as engaged in their local communities. This is highly problematic as youth are a significant portion of the United States and global population, with the U.S. Millennial population (those born between 1982 and 2004) at about 24% of the U.S. population (Rogowski & Cohen, 2015). In addition, Millennials are the most diverse population in the United States, with about 40% identifying as non-white, and 6.4% identifying as Lesbian, Gay, Bisexual or Transgendered (LGBT) (Rogowski & Cohen, 2015), as opposed to Generation X or Baby Boomers, which have less diversity in terms of race and sexual identity.

Civic engagement involves participation in communities, which includes

"formal political activities such as voting and informal civic activities such as volunteering, working with others on community issues, and contributing to charity" (Kahne, Middaugh, & Evans, et al., 2009, p. 4). Yet, around 58% of 15 to 25 year olds were "disengaged" civically (defined as not participating in at least two electoral activities (voting in any election) or civic activities, such as signing petitions or attending a town hall) (Kahne, et al., 2009, citing research from the CIRCLE website). This is problematic, in part, because a strong democracy ("rule by the people") by definition needs its citizens to be active participants in political and civic life (Pateman, 1970). Furthermore, connections have been suggested between one's individual and communal well-being and the level of activity in one's own community. Well-being has been found to be higher in locales where people are able to be more involved in civic society and the democratic process, and are more actively involved, as well-being is related to belongingness (feeling like one belongs in a particular society or community) (e.g., Finley, 2011; Swaner, 2005). Adolescence is also often a time when people question whether, how, and where they belong, making this aspect of well-being particularly relevant (Schall, Wallace & Chhuon, 2014). Moreover, adolescence is often the time when people form their civic identity and begin to spur social and political change (Syvertsen, et al., 2011; Lyons & Alexander, 2000).

One way to engage youth in civic and community action may be through games, particularly ones that invite problem solving and the crowdsourcing of solutions, perspectives, data, and decisions related to civic-related issues (crowdsourcing refers to the culling of information and activity from the public) (Schrier, 2016). These civic problem-solving games aim to solve real-world civic issues through the game itself. In this paper, I explore these types of games, provide early insights, and propose an initial set of design elements for creating and implementing games to encourage civic engagement for late adolescents and young adults. Only a few of these types of games currently exist. Thus, this paper also serves as a call to action to create these types of games and to further study whether they can support participation in civic problem solving and inspire further civic engagement and action.

Crowdsourcing and Civic Action

Crowdsourcing was initially described by Jeff Howe (2008) and while definitions differ, it typically relates to the process of using "the collective intelligence of online communities to serve specific organizational goals" (Brabham, 2013a xv). Crowdsourcing definitions often include language about participation and mutual benefit; such as one that states that it is a "participative online activity in which an individual, an institution, a non-profit organization, or company proposes to a group of individuals of varying knowledge, heterogeneity, and number, … the voluntary undertaking of a task [that]… always entails mutual benefit" (Estellés-Arolas & González-Ladrón-de-Guevara, 2012, p. 197). Brabham describes four different types of crowdsourcing (knowledge discovery and management; broadcast search; peer-vetted creative production, and distributed-human-intelligence tasking), but argues that Wikipedia is not considered crowdsourcing because the crowd and the organizers do not have an equitable, mutually beneficial relationship (Brabham, 2012).

Crowdsourcing in practice does not always have an equitable relationship between organizer and crowd. For instance, some crowdsourcing projects may involve inviting contributions from people who do not fully comprehend the implications of the project, may not be involved in the project's conception, or may even be exploited by the organization to take on labor and offset costs (Eitzel, et al., 2017). However, some projects do benefit the participant and cultivate in them a deeper interest in a topic or further action beyond the project, such as citizen science projects that help to spur interest in a particular topic or further participation in conservation or environmental

issues (Eveleigh et al., 2014; Eitzel, Jennett, Blandford, Brohan, & Cox, et al., 2017). (Citizen science is a type of research project or knowledge-making experience that involves non-professional scientists (the general public) in them, and sometimes uses activities such as the crowdsourcing of scientific data (Eitzel, et al., 2017).

A number of projects related to civic and governmental issues have recently emerged in the U.S. and globally that also use crowdsourcing to help elicit public support, solve civic-related issues, and spur civic engagement and action (Ridge, 2013; Romeo & Blaser, 2011). For instance, the UK newspaper The Guardian's encouraged its audience to conduct a large-scale analysis of journalistic documents (specifically, expense declaration forms) by using crowdsourcing techniques and game elements (Handler & Conill, 2016). Likewise, Operation War Diary invites participants to annotate real diaries from World War I soldiers in an effort to tag and label with metadata the thousands of diaries and notes related to the war. Another project, SeeClickFix, involves public participation in urban planning and governmental issues, where users can post problems in their municipality, like the presence of a pothole on a road (Brabham, 2009; Brabham, 2013a). 23 Next Stop Design, which ran in 2009-2010, invited users to participate in a transit planning contest, such as ones to design bus stop shelters on a bus stop at the University of Utah in Salt Lake City (Brabham, 2012). Crowdsourcing has also been used to analyze the assets of cultural heritage sites (McKinley, 2015). Other projects involve citizen participation in the funding of civic needs, which is similar to crowdfunding activities on websites like Indiegogo and Kickstarter, but for governmental or civic purposes (Davies, 2014).

An underlying question about crowdsourcing projects (and web-based civic action projects more specifically) is whether they are actually spurring civic engagement and involvement in communities more generally, and beyond just a single project. In other words, are these projects also supporting civic engagement and interaction with ethical, political and democratic issues and values, as suggested by research on the civic potential of games (Kahne, et al., 2009)? Research on the effectiveness of projects to spur civic action typically points to how the application or project is designed and how it is used in relation to the audience, community and its needs (in other words, the design, context, and content of the project). For instance, researchers have considered principles for the effective design of crowdsourced (1) civic action (Gordon, Baldwin-Philippi, & Balestra, 2013; Gordon & Baldwin-Philippi, 2014; Gordon, D'Ignazio, Mugar, & Mihailidis, 2017), (2) humanities-based research (Dunn & Hedges, 2012) and (3) cultural heritage (McKinley, 2015). However, beyond The Guardian case study (described earlier) (Handler & Conill, 2016), little research has considered the design of games related to civic action and civic problem solving, though research suggests that games could be effective at helping to solve problems or approach real-world issues (Schrier, 2016). The next section will explore this research further.

Designing Games for Civic Problem-Solving and Action

Can games help to inspire real-world civic problem-solving? Increasingly, game-based learning has been used in classrooms and other educational settings to teach civic knowledge, engagement, action, and participation (Raphael, et al., 2010). Raphael, et al. (2010, p. 203) explain that, "Games foster civic learning when they help players to develop knowledge, skills, and dispositions that players then apply to public matters in the world outside the game." A number of educational games have been designed to specifically support civic learning, such as the iCivics series of games, which are games created to teach middle and high school students about political processes and issues, such as elections, campaigns, passing laws, and branch-

es of government. In addition, some COTS (Commercial off-the-shelf) games have been used or modified to meet educational objectives related to civic learning, such as the SimCity or Civilization series. These types of games are sometimes referred to as educational games or "serious games," which are games that focus on purposes beyond just entertainment, such as health, education or military training. Games have also been used to teach about civic and social issues, such as Migrant Trail (which explores issues around migration) and Fake It To Make It (which examines how misinformation (or "fake news") is created and spread). These types of games are sometimes called "games for change" or games that aim to inspire social, cultural, political and economic change (see www.gamesforchange.org).

The aforementioned games seek to teach about civic issues or enable the practice of civic skills; however, this paper questions the design and use of games that do not just teach about civic issues, but aim to solve real civic problems, spur civic action, and create new civic knowledge through and within the game itself. For example, civic problem-solving games could help us to better understand how citizens decide whether to vote, how they choose among candidates, and even how to intervene to increase voter participation (such as in the case of U.S. college students and young adults). Or, these games could possibly enable large-scale participation in real-world problem solving of civic issues, such as what to do about motivating recycling, making family leave policies more equitable, or connecting people with the healthcare coverage they need (Schrier, 2016). These games could also encourage solving local and community-based issues, such as those in schools, community centers, or local parks (Schrier, 2016).

A number of current games support citizen science participation, or civic participation in scientific and STEM (science, technology, engineering & mathematics) knowledge and problem solving (Lieberoth, Kock, Marin, Planke, & Sherson, 2014; Schrier, 2016). For instance, scientists at Stanford and Carnegie Mellon University developed EterRNA, a game that crowdsources designs for new RNA (ribonucleic acid) molecules, which can help scientists understand how to better fight certain diseases. Likewise, in Quantum Moves, participants help to deepen understanding of quantum computing (computing using quantum mechanical properties, or processes that better approximates the complexity of the world) through a game (Lieberoth, et al., 2014).

However, during the research for this paper, no U.S.-based video games were found that primarily involve solving local or global civic issues (rather, these games typically seek to solve scientific and other types of issues, as described earlier). Two non-U.S. interactive experiences may be considered civic problem solving games. For instance, users of Mapatón (Mexico City) gained points and prizes by helping to map the bus routes (OECD, 2016). Likewise, Traffic Agent invites students to report on issues and hazards while going to school in Oslo, Norway (EuroCities, 2016). (Note that the users of the Mapatón and Traffic Agent app may have been contributing data through the app or crowdsourcing website, and then gaining rewards, but it is not clear if they were playing a fully-formed game, or participating in a "gamified" crowdsourcing experience. Gamification involves the process of adding rewards, such as badges, points, or coins, to a non-game environment or process, such as school, a hospital setting, or crowdsourcing website (Schrier, 2016). In other words, the line between game and gamified experience is ambiguous.) Moreover, some non-digital games have been used to solve civic problems. Play the City, a firm out of Amsterdam and Istanbul, used a physical game to support the collaborative problem solving activity of around 100 participants who sought to remodel a market in Khayelitsha, Cape Town in South Africa (see www.PlaytheCity.nl).

Thus, there are few games that currently enable real-world civic problem solv-

ing. However, prior research on games and learning suggests that games may be potentially effective for inspiring real-world civic action and engagement, particularly for adolescents and young adults. First, games can **simulate and situate real-world problems** and complex systems (Gee, 2003; Schrier, 2016; Shaffer, 2006). Shaffer describes a simulation as a real or virtual representation of part of the world (Shaffer, 2006). Experiencing and interacting with a simulation of a process, place, or problem allows the participant to more easily understand its nuances, drivers, and dynamics over time. For instance, we could use a simulation to look at the conditions of a lake over time. Participants could to try out different parameters (such as adding pollutants, changing weather conditions, or taking away predators of lake inhabitant populations), and then can then experience any consequences, without having to actually affect a real lake and cause possible dangers. Second, games can **enable team-based, community-based, and/or collaborative problem solving** (Gee & Hayes, 2012; Schrier, 2016; Steinkuehler, 2007; van der Meij, et al., 2011). Problem solving can be effective in teams, because the process may require information, talents, and experiences beyond any one individual's capabilities (Hung, 2013; Wuchty, et al., 2007). Third, through games, computers and human beings can work together such that the **capabilities of each are enhanced and even optimized**, which relates to von Ahn's notion of human computation, or the concept of human beings and computers working together to solve complex and large-scale problems that neither could individually solve (von Ahn, 2005; von Ahn & Dabbish, 2008). Fourth, games can be **highly motivating**, which can further encourage engagement in problem solving (Eseryel, Law, Ifenthaler, Ge, & Miller, 2014). However, different types of play experiences motivate different types of people, and males and younger people may be more motivated by competition than females and people over-35 (Yee, Dicheneaut, & Quantic Foundry, 2016), and some people will be demotivated by competition and competitive elements (Becker & Nicholson, 2016). Finally, younger people (kids, adolescents, and young adults) are avid game players, with around 73% having played video games in the previous two months (Snider, 2014).

Although this research generally suggests the effectiveness of games in this area, more empirical testing is needed to tease out the specific ways civic-problem solving games may or may not support civic learning, engagement and action by younger people. We need more research that specifically asks: can game environments that integrate crowdsourcing techniques and large-scale human participation help to spur civic action and solve civic problems, and, particularly, engage youth populations? Can games effectively solve real-world civic problems through the game itself, and also spur civic action outside of the game as well (Ridge, 2013). This paper serves to provide early insights into possible design principles for designing and using these civic problem-solving games. In the next section, I consider how the initial design principles were developed given the few relevant and available games.

METHODOLOGY

A challenge with creating an initial set of design principles is that there are few civic learning games and no U.S.-based civic problem-solving games that are currently available to play and use. Thus, I elicited possible design principles by looking at design elements culled from games and other media from related or intersecting domains. The reason for using a number of interrelated domains is that even though there are few civic problem-solving games, and little research on them or their design principles, we can investigate games from related fields. To determine the related domains, I reviewed the aforementioned literature and created a conceptual model of "civic problem solving games," which includes general

domains such as problem solving, civic learning, games, citizen science, and crowdsourcing. I used the literature to consider interactions and intersections among the domains, and came up with the resulting specific domains: (1) civic learning games; and (2) problem solving/crowdsourcing/ citizen science games. Thus, these two intersecting domains were used to help identify a broad and inclusive series of games and other media that could be reviewed and studied further to help elicit initial design principles.

Next, I systemically identified games that fit these specific domains and are currently available and playable. To do this, I first looked at "civic learning games" by reviewing games on the iCivics platform, the largest online collection of games that aim to teach adolescents and young adults about civic issues and processes, and support civic engagement and action (Blevins, LeCompte, & Wells, et al., 2016; LeCompte, et al, 2011). There were 19 games on iCivics when the projects were reviewed in November 2016.

I also reviewed "problem solving/ crowdsourcing/citizen science games" by looking at SciStarter.org, a platform managed by Darlene Cavalier through Arizona State University (ASU), which has 1600 projects related to citizen science, including 19 projects tagged as a "game" as of November 2016 (in November 2017 there were 25 projects tagged as a "game.") As of November 2016, SciStarter.org is the largest online database of citizen science projects from among the four main platforms identified by the Wilson Center (2015). Many of the citizen science projects use crowdsourcing, including the input of data and interpretation of data, as part of their project.

To elicit initial design principles, I randomly selected three games from each of the two platforms to analyze: three games from iCivics (Branches of Power, Win the White House, and Crisis of Nations) and three games from SciStarter.org (Phylo, Nanocrafter and Mozak) (see Table 1) I investigated each game by conducting a design, content, and textual analysis using three different types of frameworks:

(1) **Design frameworks**, to help reveal game design elements, including the: (1a) The MDA framework (Hunicke, LeBlanc, & Zubek, 2004), which describes an approach to game design that includes the mechanics, dynamics and aesthetics and (1b) Elemental Tetrad (Schell, 2008), which describes an approach to design that uses four components (mechanics, aesthetics, story, and technology).

(2) **A pedagogical framework**, proposed by Milhailidis and Gerodimis (2016), for "developing and exercising civic voice in global digital culture" (p. 417); and

(3) **A social and civic analysis framework**, the civic inclusion framework (McDowell & Chinchilla, 2016), an approach that aims to bridge social divides (e.g., gender, social class, different abilities) to enhance "functional, cohesive, and inclusive community engagement" or fully accessible and equitable civic engagement by all (p. 512).

I used a grounded theory approach (Corbin & Strauss, 1990), and inductively created a list of design principles by analyzing the design, pedagogical, social, and civic elements present in the six games. Specifically, I reviewed the design features, game content, game context, player interactions, possible choices, pedagogical, social and civic approaches, mechanics, storytelling, tutorial, community, and artistic elements of the six games. Any terms, elements and principles were collected and iteratively labeled using both in vivo (labeling of significant terms) and thematic (labeling of general themes) (Saldana, 2011). Redundant and overlapping terms were grouped together and iteratively organized until the principles were grouped into distinct clusters. These groupings became the initial list of design principle categories. The design principles were further validated by re-reviewing literature related to the general conceptual domains (problem solving, civic learning, games, citizen science, and crowdsourcing), and identifying any gaps. Finally, an initial list of 20 design principles

was developed for creating and deploying games that address civic problems, opportunities and spur civic action in youth, which should in the future be empirically investigated and further validated.

Design Principles

In this section, I discuss the initial design principles that emerged from my analysis (see Table 2). Many of them are more specific to civic education and problem solving (such as connecting to real-world civic issues and problems), though some of them could also be applied to many other types of games (such as playing a role, interacting with others, or using audio appropriately). Although many of these principles could be applied to other types of games, I have included all the principles as they should each be further considered in light of the goals and context of a particular civic problem or project. Thus, although the word "games" may be used in many of the principles, they specifically refer to civic problem-solving games.

Games should provide connections to real-world civic issues. All games need to include clear and relevant goals, missions, and tasks. Civic problem solving games also need to connect to real-world problems and goals. The game goals should map to real-world pedagogical, civic, activist, knowledge production, and/or research goals. The games should also have in-game actions, stories, data, or views that map to real-world counterparts, such that the digital and analog parts are bridged (Mihailidis & Gerodimos, 2016; McDowell & Chinchilla, 2016). For instance, Phylo's goals map to real-world health issues. Other games have tools and activities that are modeled after real-world creations, such as the debates and "media" trend reports in Win the White House, or the genetic diagrams and bonding actions in Nanocrafter.In addition, players should be allowed to choose from among a number of goals, switch goals, or withdraw from a goal, such as by resigning or changing to a new goal, particularly if a goal is personally upsetting or particularly compelling (for instance, if a particular health issue recently affected a family member). The games themselves may also function as calls-to-action and further volunteer support for real world problems.

Games should include authentic civic problem solving. Civic problem solving games should enable authentic problem solving processes—with an understanding that a game cannot necessarily rep-

Table 1. The Six Games Included in the Study

Game Title (Designer/Developer)	Brief Summary
Phylo (created by Jérôme Waldispühl, McGill University)	Players move around and align a sequence of colorful blocks (which represent RNA sequences) to help researchers trace genetic diseases.
Nanocrafter (created by University of Washington/Center for Game Science)	Players can craft new virtual synthetic DNA to help solve specific real-world problems.
Mozak (created by University of Washington/Center for Game Science/ Allen Institute for Brain Science)	Players trace images of neurons to help scientists learn more about the brain.
Branches of Power (iCivics)	Players take on the role of the three branches of government to pass bills and understand the system of checks and balances.
Win the White House (iCivics)	Players take on the role of a candidate for US president and respond to issues through debates and speeches to try to collect enough electoral votes to win.
Crisis of Nations (iCivics)	Players play as citizens of an imagined country and need to cooperate and compete with other countries on a variety of issues in real-time.

licate all real-world interactions and is always a designed version of a problem. Players should be able to work on problems that use real data, actions, tools, and methods (Shaffer, 2006). Moreover, players may need to first approach more simplified versions of complex problems until they get more knowledgeable and adept at solving them. Problems should be contextualized, structured, and broken down into their components to enhance problem solving ability (Jonassen, 2000; Jonassen & Hung, 2008). For instance, Nanocrafter has a series of tutorial "levels" where players learn the rules step-by-step and solve smaller parts of a larger problem before approaching more complex real-world problems.

Games should properly constrain civic problems and also provide randomness and variety. Games typically provide enough structure, boundaries, constraints, and clear rules such that a player understands what to do in the game and how to do it, as well as what not to do (Fullerton, 2008). However, games should also provide some flexibility in the form of random actions or consequences and some variety as to what can be done in the game and how it can be accomplished. For example, games may feature different modes of play (single player vs. multiplayer), distinct roles (Executive Branch or Legislative Branch), and/or different types of information (such as differing game goals to focus on). Games may also vary the types of problems offered. In Phylo, players can choose from a menu of options of which problems to solve, such as heart and muscle diseases, cancers, or infectious diseases.

Players should experience complex civic system dynamics. To support problem solving, players should have the opportunity to see how different choices, actions, and possible solutions can affect not only the outcomes in the game, but the entire system (Salen & Zimmerman, 2004). In other words, the game should simulate a complex system to help players better understand and experience the problem, its consequences, and the dynamic forces affecting it. For example, in Branches of Power, players experience the U.S. government's system of checks and balances while playing a game that enables the player to enact different checks and experience the results dynamically.

Games should enable iteration of civic solutions. Civic problem solving games should enable iteration, "trial and error," and experimentation with the data and solutions related to civic issues. Players should be able to revise and iterate through possibilities and solutions to see how different choices can affect outcomes to further aid in their understanding of system dynamics and possible problem solutions (Zimmerman, 2003). For example, players can rewind, repeat, and erase mistakes in Mozak.

Players should be able to compare and verify other civic solutions. Players should have the opportunity to compare approaches and verify which work and do not work. This type of verification is already taking place in many crowdsourcing and citizen science games, where players verify each other's approaches, responses, and data (Prestopnik & Crowston, 2011; Guy, et al., 2011). Some of the games reviewed have competitive elements, such as head-to-head (or direct) competition, and leaderboards, which involve a comparison of scores and solutions found. The competitive and comparative elements may help players further learn about approaches to different problems, as well as help to further verify other's solutions to open problems. For instance, in Mozak, players get estimated scores until they are fully verified in comparison to other players' actions.

Players should make meaningful civic-related choices and get meaningful feedback. Players should be able to make meaningful choices and/or take actions based on relevant community or political data, perspectives, or information. These choices should then have meaningful consequences and feedback within the game, such as opening up certain ways of solving a problem, providing rewards or penalties (e.g., increases or decreases in score, collectibles, or extra powers), as well as

changes in the gameplay or how NPCs respond (Fullerton, 2014). For instance, in the game Win the White House, players can see an electoral map that shows which states they are "winning" and can see a meter that tells them how many electoral votes they have so far.

Players should experience and relay different civic perspectives. Players should have the opportunity to express their perspectives, learn about others' views, and also experience alternative views on topics or issues (Schrier, 2017). Players may even be encouraged to provide the point and counterpoint to a topic. For instance in Win the White House, players are encouraged to pick issues supported by a political party, as well as an issue supported by the opposing party, to choose as issues they are "running on" for their platform. The player then earns votes based on these issues. Researchers also recommend providing opportunities for players to share personal views, learn others' views, and connect with those who do not agree with them to help in strengthening civic deliberation and discourse (Mihailidis & Gerodimos, 2016; McDowell & Chinchilla, 2016).

Players should be able to take on different civic roles. One of the key ways of learning new perspectives is to take on different roles, and even switch roles to see new and differing viewpoints (Schrier, et al., 2014). For instance, in Branches of Power, players can switch between U.S. branches of government, such as the executive or legislative branch, to experience the different perspectives on the process of passing a bill. In the legislative branch, players need to gain enough votes by choosing different parts of the bill; in the executive branch, players need to veto or sign (approve) the bill. Players may even have proprietary information, or information only they have, which they can use to compete or collaborate with others. In Crisis of Nations, each player takes on the role of a fictional country that has to work with other countries to solve crises. Each country has a resource goal (economics, espionage, military or policy) that they need to complete, but they also have collaborative goals of offering resources alongside other countries to solve crises.

Players should be able to manage civic-related resources. In the reviewed games, players were able to manipulate and manage relevant and useful resources, objects, and actions, which may help players better understand the complexities of the system or problem (Stefanska, et al., 2011). Game actions often included management of a resource (e.g., money, time), objects, and actions related to the real-world problem. For instance, in Win the White House, players must decide how to spend money to earn votes for their candidate—such as to use the money to poll for votes (which provides useful information, but does not earn votes) or to place media buys (which could earn votes, but is expensive).

Players should be able to work with realistic civic data. Players should be able to manipulate and analyze real-world data, and use this information to make decisions and choices in the game or to support claims (Shaffer, 2006). Data could be directly connected to the real-world, such as in the case of Mozak's images of brain cells. Or, data could be based on real-world processes and topics, though fictional, such as in the case of the state-by-state polling statistics and electoral votes in Win the White House.

Civic information should be organized clearly. An organized, simplified visual display of information and data was an integral component of all of the games analyzed, including the use of relevant colors, shapes, symbols, and icons (McCloud, 1993). For instance, in Phylo, players can manipulate simple objects that represent more complex real-world counterparts, like colorful blocks standing in for genetic material. In Win the White House, icons were used to represent concepts and issues; for instance, a heart with a rainbow to represent marriage equality.

Audio should be used meaningfully to relay civic information. The games

reviewed use distinct sounds to cue mistakes, as well as to convey success, completion, rewards, hints and other actions. Audio was used to denote errors as well as to provide feedback on any successes or the completion of the task. Sound was also sometimes used to provide hints or to register that a clue was being offered or an event was happening.

Games should include real "time." The use of time, including real-time events and time-based activities, adds further authenticity and relevancy to the gameplay. For instance, in Crisis of Nations, a player cannot pause, but must make decisions in real-time and continue to play, otherwise they will automatically fail. Moreover, as the game proceeds, the designers of Phylo, Nanocrafter or Mozak, may add or unlock new real-world, as-yet unsolved problems that players can work on.

Games should include everyday and local civic issues. The games should involve everyday issues and citizen participation such that the stories and problems expressed not only revolve around candidates, government officials or other established representatives (Mihailidis & Gerodimos, 2016; McDowell & Chinchilla, 2016), but also connect to one's personal and local community's needs (e.g., lack of affordable housing, need for improved playgrounds), to help further involve people in their own communities and personally relevant issues. In other words, these games could focus on local issues rather than just on national or international issues, helping to bridge the game (digital environment) with the local, face-to-face (analog or non-digital community.

Players should be able to interact with others. Players should be able to interact with other people, whether real people (other players) in person or through the game (virtually); or, they should be able to interact with non-player characters (NPCs), which are game characters not controlled by other players, but by the computer game. This type of interaction could involve competition, but it could also involve collaboration (a process of shared interaction, creation and completion, which leads to mutually beneficial outcomes) or cooperation (the mutually beneficial sharing of goals and tasks, but not necessarily involving direct interaction) (Schrier, 2016). Some of the games analyzed provide incentives for players to cooperate with other players or even

Table 2. Design Principles for Civic Problem-Solving Games.

1. Games should provide connections to real-world civic issues.
2. Games should include authentic civic problem solving.
3. Games should properly constrain civic problems and also provide randomness and variety.
4. Players should experience complex civic system dynamics.
5. Games should enable iteration of civic solutions.
6. Players should be able to compare and verify other civic solutions.
7. Players should make meaningful civic-related choices and get meaningful feedback.
8. Players should experience and relay different civic perspectives.
9. Players should take on different civic roles.
10. Players should be able to manage civic-related resources.
11. Players should be able to work with realistic civic data.
12. Civic information should be organized clearly.
13. Audio should be used meaningfully to relay civic information.
14. Games should include real "time."
15. Games should include everyday and local civic issues.
16. Players should be able to interact with others.
17. Games should be customizable and personalizable based on one's community or civic interests.
18. Games should support the accessibility of the community.
19. Games should scaffold civic information and learning.
20. Games should encourage community interactions.

non-player characters (NPCs). For instance, in Crisis of Nations, players earn bonuses if they cooperate with other players, even if they are also in competition. The crises in this game can only be solved through cooperation and sharing expertise, perspectives, and information among the four countries that are playing the game (countries can be controlled by other players in the multiplayer mode, or by the computer in the single-player mode).

Games should be customizable and personalizable based on one's community or civic interests. Components of a game should be customizable by the player, such as one's avatar (the character in a game that the player controls.) In all three of the civic learning games, players have the opportunity to customize different aspects of the game, such as by choosing their avatar from among multiple avatars (in the case of Win the White House) or by naming their country (in the case of Crisis of Nations). Players of Phylo can also customize the language used in the game and have options for 11 different languages, including French, Hebrew, English, Spanish, and Japanese.

Games should support the accessibility of the community. The technologies and platforms used in these games seem to aim for greater accessibility. McDowell & Chincilla recommend making the games for those who are least likely to access it and are most marginalized, rather than the majority or mainstream user (2016). The six games investigated were browser-based with minimal graphical and processing speeds required. While not everyone has access to a computer that can connect to the Internet, designing free online games greatly enhances accessibility beyond platforms with less penetration, such as consoles or handheld devices, which are rarely used in schools and may be cost-prohibitive for adolescents or young adults. Accessibility also involves access the designers and researchers related to the game. For instance, in Mozak and Nanocrafter, players were able to connect with the designers (through embedded chats) to encourage feedback and improvements to the game, as well as to ask questions and learn game-playing tips and strategies.

Games should scaffold civic information and learning. Games should include ongoing instruction through tutorials, embedded cues, and other nudges and messaging (Melero, et al., 2011; Thaler & Sunstein, 2009). The analyzed games all offered tutorials (some were optional) and provided contextual clues, additional information on request, just-in-time cues, tips from the designers, and other types of scaffolding and support throughout the gameplay.

Games should encourage community interactions. Researchers recommend more opportunities for engaging in dialogue, particularly with those in one's own community (Mihailidis & Gerodimos, 2016; McDowell & Chinchilla, 2016). For instance, games should provide opportunities for players to share personal perspectives, learn other views, and connect with those who do not agree with them. Using the game to help reveal and shift power dynamics in one's community might be particularly relevant to finding new ways to solve problems and encourage greater access to the problem-solving process (McDowell & Chinchilla, 2016).

CONCLUSION

Increasingly, there have been web-based projects that aim to engage youth and adults in solving real-world civic problems, such as using the crowdsourcing of civic data and information. However, there are few real-world civic problem-solving games that also have been designed to facilitate this. This paper serves as a call to action to design and implement more of these types of civic problem-solving games, as well as evaluate them for their potential to engage youth in civic learning, action and participation. For instance, these games could be studied in terms of their ability to increase curiosity, interest and motivation for civic issues and engagement; for their short-term and long-term impact on civic

action and engagement; for their effectiveness in solving real-world civic problems; and also for their ability to help students learn and practice civic-related skills. To aid in the creation and use of civic problem-solving games, this paper generated an initial list of 20 possible design elements that could be incorporated into games for civic action, engagement and problem solving. To do this, I randomly selected and analyzed six games—three that are real-world problem solving games (from the SciStarter.org website), and three that are related to civic learning and education (from the iCivics website). These are preliminary design principles and should be further tested and validated to understand how each principle might help motivate problem solving, civic engagement, and action for youth; how accurately and effectively they help people solve real-world problems through games; and how they each may support action in a number of domains that are currently underserved, such as those related to solving civic issues and problems.

REFERENCES

Becker, K. & Nicholson, S. (2016). Gamification in the classroom: Old wine, new badges. In K. Schrier (Ed.) *Learning, Education & Games Vol. 2: Bringing Games into Educational Contexts.* (61-86) Pittsburgh, PA: ETC Press.

Blevins, B., LeCompte, K. & Wells, S. (2016). Innovations in civic education: Developing civic agency through action civics. *Theory and Research in Social Education.* Published online on August 22, 2016.

Brabham. D. (2009). Crowdsourcing the Public Participation Process for Planning Projects. *Planning Theory*. *8*(3): 242-262.

Brabham, D. (2012). The Effectiveness of Crowdsourcing Public Participation in a Planning Context. *First Monday. 17*(12). http://firstmonday.org/article/view/4225/3377

Brabham, D. (2013a). *Crowdsourcing.* Cambridge, MA: MIT Press

Brabham, D.(2013b). Using Crowdsourcing in Government. Whitepaper. Retrieved June 16, 2017, from http://www.cbs.dk/files/cbs.dk/using_crowdsourcing_in_government.pdf

CIRCLE Website. (2016). An estimated 24 million young people voted in 2016 election.

Davies. R. (2014). *Civic Crowdfunding: Participatory Communities, Entrepreneurs, and the Political Economy of Place.* Masters Thesis. Massachusetts Institute of Technology. Cambridge, MA.

Dunn, S. & Hedges, M. (2012). Crowdsourcing Scoping Study: Engaging the Crowd with Humanities Research. London: Centre for e-Research, Dpt. of Digital Humanities, King's College London.

Eitzel, M., Cappadonna, J., Santos-Lang, C., Duerr, R., Virapongse, A., West, S., Kyba, C., Bowser, A., Cooper, C., Sforzi, A., Metcalfe, A., Harris, E., Thiel, M., Haklay, M., Ponciano, L., Roche, J., Ceccaroni, L., Shilling, F., Dörler, D., Heigl, F., Kiessling, T., Davis, B., Jiang, Q. (2017). *Citizen Science Terminology Matters: Exploring Key Terms. Citizen Science: Theory and Practice, 2* (1): 1, pp. 1–20, DOI: https://doi.org/10.5334/cstp.96

Eseryel, D., Law, V., Ifenthaler, D, & Ge, X. & Miller, R. (2014). An Investigation of the Interrelationships between Motivation, Engagement, and Complex Problem Solving in Game-based Learning, *Educational Technology & Society, 17*(1): 42–53.

Estellés-Arolas, E. & González-Ladrón-de-Guevara, F. (2012). Towards an integrated crowdsourcing definition. *Journal of Information Science. 38* (2): 189-200.

Eveleigh, A., Jennett, C., Blandford, A., Brohan, P. and Cox, A.L., (2014). Designing for dabblers and deterring drop-outs in citizen science. In: Proceedings of the 32nd annual ACM conference on Human factors in computing systems (pp. 2985–2994). ACM. DOI: https://doi.org/10.1145/2556288.2557262

EuroCities (2016). Oslo's Traffic Agent App. Accessed at: http://nws.eurocities.eu/MediaShell/media/CitiesInAction_TrafficAgent_Oslo_Jul16.pdf

Fullerton, T. (2014). *Game Design Workshop, 3rd Edition*. Boca Raton, FL: CRC Press.

Gee, J. (2003). *What games have to teach us about learning & literacy.* New York, NY: Palgrave McMillan

Gee, J. & Hayes, E. (2012). Nurturing affinity spaces and game-based learning, in C. Steinkuehler, K. Squire, & S. Barab (Eds). *Games, Learning, and Society: Learning and Meaning in the Digital Age,* (129-153) New York, NY: Cambridge University Press.

Gordon, E. & Baldwin-Philippi, J. (2014). Playful civic learning: Enabling reflection and lateral trust in game-based public participation. *International Journal of Communication*. *8*:759-786.

Gordon, E., Baldwin-Philippi, J. & Balestra, M. (2013), *Why we engage: How theories of human behavior contribute to our understanding of civic engagement in a digital era*. Berkman Center.

Gordon, E. D'Ignazio, C., Mugar, G. & Mihailidis, P. (2017). Civic Media Art and Practice: Toward a Pedagogy for Civic Design. *ACM Interactions.* March-April 2017.

Guy, I., Perer, A., Daniel, T., Greenshpan, O., & Turbahn, I. (2011). Guess Who? Enriching the social graph through a crowdsourcing game. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, p 1373-1382.

Hall, P. (2008). *Voting: Is it Just for Old People?* Thesis. Georgia.

Handler, R. & Conill, R.F. (2016). Open Data, Crowdsourcing and Game Mechanics. A Case Study on Civic Participation in the Digital Age. *Computer Supported Cooperative Work (CSCW), 25*(153-166).

Howe, J. (2008). *Crowdsourcing: why the power of the crowd is driving the future of business*. New York: Three Rivers Press.

Hung, W. (2013). Team-Based Complex Problem Solving: A Collective Cognition Perspective, *Educational Technology Research and Development. 61* (2013): 365–84.

Hunicke, R., LeBlanc, M. and Zubek, R. (2004). "MDA: A formal approach to game design and game research," In *Proceedings of the Challenges in Games AI Workshop*, Nineteenth National Conference on Artificial Intelligence, San Jose, CA.

Kahne, J., Middaugh, E., & Evans, C. (2009). The civic potential of video games. Retrieved June 10, 2017, from https://dmlcentral.net/wp-content/uploads/files/Civic_Potential_of_Games.pdf

Lieberoth, A., Kock, M., Marin, A., Planke, T., & Sherson, J.F (2014). User acquisition, engagement and early results from the citizen cyberscience game *Quantum Moves*. A midstream report (working title). *Human Computation,* 1.

McCloud, S. (1993). *Understanding Comics*. New York, NY: William Morrow.

McDowell, C. & Chinchilla, M.Y. (2016). Partnering with communities and institutions. In E. Gordon & P. Mihailidis, Eds. *Civic Media: Technology, Design, and Practice.* Cambridge, MA: MIT Press.

McKinley, D. (2015). *Design Principles for Crowdsourcing Cultural Heritage*. PhD. Findings Report. Retrieved from http://nonprofitcrowd.org/crowdsourcing-heuristics

Melero, J., Davinia, H.-L, & Blat, J (2011). A review of scaffolding approaches in game-based learning environments. 5th European Conference on Game-Based Learning, Athens, Greece.

Mihailidis, P. & Gerodimos, R. (2016). Connecting Pedagogies of Civic Media: The Literacies, Connected Civics, and Engagement in Daily Life. In E. Gordon & P. Mihailidis, Eds. *Civic Media: Technology, Design, and Practice.* Cambridge, MA: MIT Press.

Niemi, R.G. & Hanmer, M. (2010). Voter Turnout Among College Students: New Data and a Rethinking of Traditional Theories. *Social Science Quarterly. 91*(2): 301-323.

OECD, (2016). "Case Study: Mapaton," accessed at: https://www.oecd.org/gov/innovative-government/embracing-innovation-in-government-mexico.pdf

Pateman, C. (1970). *Participation and Democratic Theory.* New York, NY: Cambridge University Press.

Prestopnik, N. & Crowston, K. (2011). Gaming for citizen science: Exploring motivation and data quality in the context of crowdsourced science through the design and evaluation of a socio-computational system. E-Science Workshops, 2011 IEEE Seventh International Conference.

Ridge, M. (2013). From Tagging to Theorizing: Deepening Engagement with Cultural Heritage through Crowdsourcing. *Curator: The Museum Journal. 56*(4): 435-450.

Rogowski, J. C. & Cohen, J. C. (2015). Black Millennials in America.www.blackyouthproject.com, Accessed at: https://blackyouthproject.com/wp-content/uploads/2015/11/BYP-millenials-report-10-27-15-FINAL.pdf

Romeo, F. and Blaser, L. (2011). Bringing Citizen Scientists and Historians Together. Museums and the Web 2011, Philadelphia.

Saldana, J. (2011). *Fundamentals of Qualitative Research (1st Edition)*. New York, NY: Oxford University Press.

Salen, K. & Zimmerman, E. (2004). *Rules of Play.* Cambridge, MA: MIT Press.

Shaffer, D. (2006). *How Computer Games Help Children Learn.* New York, NY: Palgrave Macmillan.

Schell, J. (2008). *The Art of Game Design*, New York, NY: Morgan Kaufmann.

Schrier, K., Diamond, J., & Langendoen, D. (2010). Using *Mission US: For Crown or Colony?* To develop empathy and nurture ethical thinking. In K. Schrier & D. Gibson (Eds.) Ethics and Game Design: Teaching Values through Play. Hershey, PA: IGI Global.

Schrier, K. (2016). *Knowledge Games: How Playing Games Can Solve Problems, Create Insight and Make Change.* Baltimore, MD: Johns Hopkins University Press.

Schrier, K. (2017). Designing games for moral learning and knowledge building, *Games & Culture*. Online First.

Snider, M. (2014). Survey: Video gamers more social and more socially conscious. *USA Today,* June 5, 2014.

Stefanska, J, Magnuszewski, P., Sendzimir, J., Romaniuk, P. Taillieu, T., Dubel, A. Flachner, Z., & Balogh, P. (2011). A gaming exercise to explore problem-solving versus relational activities for river floodplain management. *Environmental Policy & Governance, 21*(6): 454-471.

Steinkuehler, C. (2007). Massively multiplayer online gaming as a constellation of literary practices. *E-Learning. 4*(3): 297-318.

Syvertsen, A., Wray-Lake, L., Flanagan, C., Osgood, D.W. & Briddell, L. (2011). Thirty year trends in U.S. adolescents' civic engagement: A story of changing participation and educational differences. *Journal of Research on Adolescence, 21*(3): 586-594.

Thaler, R. & Sunstein, C. (2009). Nudge. New Haven, CT: Yale University Press.

Wuchty, S., Jones, B. F., & Uzzi, B. (2007). The increasing dominance of teams in production of knowledge, *Science*, 316: 1036-39.

van der Meij, H., Albers, E., & Leemkuil, H. (2011). Learning from games: Does collaboration help," *British Journal of Education, 42* (4): 655-64.

von Ahn, L. (2005) *Human Computation*. Thesis. CMU, Pittsburgh, PA.

von Ahn, L. & Dabbish, L. (2008). Designing games with a purpose. Association for Computing Machinery. Communications of the ACM; New York 51(8): 58.

Yee, N., Dicheneaut, N. & Quantic Foundry. (2016). Gamer motivation model. http://quanticfoundry.com/reports

Zimmerman, E. (2003). The iterative design process. In B. Laurel (Ed.), *Design Research: Methods and Perspectives.* Cambridge, MA: MIT Press.

AUTHOR NOTE

Dr. Karen Schrier is an Associate Professor at Marist College, where she is the Director of the Games and Emerging Media program and the Play Innovation Lab. She is the editor of the *Learning, Education & Games book series* (ETC Press) and the author of *Knowledge Games: How Playing Games Can Solve Problems, Create Insight, and Make Change* (Johns Hopkins University Press).

Correspondence concerning this article should be addressed to Dr. Karen Schrier.

Marist College, 3399 North Road, Poughkeepsie, NY, 12560, USA,

Email: Karen.Schrier@marist.edu