What's in a name?: naming games that solve real-world problems

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Investigating Typologies of Games as Research Environments

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ABSTRACT

Games are increasingly being used to answer research questions; however, no clear typology has been established to organize these types of games. For instance, games such as *EteRNA*, *Phylo*, and *Foldit* have been specifically designed to answer research questions and solve real-world problems, whereas Commercial off-the-shelf games (COTS) games, such as *Eve Online, World of Warcraft* and *Fable III* have been used by researchers to address a variety of questions—such as ones about morality, epidemiology, motivation, or how people learn. In this workshop position paper, I briefly review relevant literature and posit a possible typology for research games.

CCS CONCEPTS

• **Human-Centered Computing** → **Collaborative and social computing**; *Collaborative and social computing theory, concepts, and paradigms*; Computer supported collaborative work • **General and Reference** → Document types; *Computing standards, RFCs and guidelines*

KEYWORDS

Crowdsourcing; games with a purpose; gaming; games for research

1 EXTENDED ABSTRACT

Since their inception, we have been using games to investigate questions about humanity, science, and the social sciences. For instance, through how we play a game, we can learn more about who we are, as well as who we might become. Games have informally provided valuable insight into human behavior, society, and social structures. But in the past few decades, games have been more systematically used as research environments. Moreover, the frequency of designing games specifically to be used "for research" has increased, such as games created with the primary purpose of advancing knowledge and answering research questions. As games are increasingly used for research purposes it is helpful to systematically categorize them to discover common themes and purposes across disciplines and game types, as well as to create a shared language for discussing these games and designing new ones. It is also useful to create a taxonomy such that we can understand any gaps, work toward reducing those gaps, and imagine the types of games that we should create and which might be useful as future needs, interactions, questions, and technologies evolve.

There are a number of ways that commercial off-the-shelf games could be used for research purposes. For instance, commercial games have been used by epidemiology researchers to understand outbreaks. Lofgren and Fefferman used *World of Warcraft (WoW)* to investigate responses to real-world biological outbreaks by looking at *WoW*-creator Blizzard's accidental release of a digital "monster" that wiped out many avatars with lower HPs (hit points) [1]. They analyzed the responses of the surviving players and were able to create better models of outbreak scenarios. Games have also been used to study human behavior in terms of ethical decision-making and interactions surrounding ethical dilemmas. For instance, Steinkeuhler & Simkins used *WoW* to study moral reasoning [2] and Schrier used *Fable III* to create an initial model of ethical thinking, which includes empathy, reflection, and reasoning [3]. Educators may also use games as ways to assess their students and help research their individual and class-wide needs; a game could also potentially use this feedback to adapt to the player, such as in the case of *Fasttmath*. Moreover, companies may use games to research their own players, and to find ways to revise their games to maximize profit and engagement in their games. For instance, Zynga uses large-scale, real-time data analytics to inform current and future social games [4]. Game companies are also creating research initiatives within their own games, such as *Eve Online*'s Project Discovery initiative, which enlists players in mapping real proteins in the body [5], or categorizing real galaxies.

Games are also being made by researchers to specifically research real-world open problems and questions, such as ones from science, humanities, and social sciences--and beyond. Games such as these enlist "amateur" researchers to collaborate with scientists; collect and/or analyze data; observe and record; annotate and tag; or share perspectives [6]. These games are typically called "citizen science" games, "crowdsourcing games," and "human computation games." For the purposes of brevity I will call them "knowledge games" because they create new real-world knowledge through the playing of the game [7]. For instance, we now have games that aim to support science research initiatives, such as *Foldit*, which enable players to experiment with and fold 3-D representations of proteins and submit their designs or EyesonALZ's *StallCatchers*, where players help researchers better understand Alzheimer's Disease by identifying and tagging structures in cellular images.

While most of these types of games aim to research science questions, knowledge games are also being used for humanistic and social scientific research, such as in psychology, education, history, literature and art. For instance, Giant Otter's *SchoolLife* presents social scenarios to players to help crowdsource information abut how people react to bullying; these findings in turn have supported their creation of AI-driven virtual characters to make this game's scenarios more realistic. Players also can play Tiltfactor Lab's *Beanstalk game* and assist in transcribing text from images taken from botanical books. This in turn could help researchers who are analyzing botanical history and other types of histories and literature.

These knowledge games are theoretically effective, in part, because they combine the "best parts" of human beings and computers such that the sum is greater than its parts. This is often called "human computation" [8] because it optimizes the talents and resources of both humans and computers, who are working together across distance and time. For example, human beings are good at pattern recognition and spatial manipulation, whereas computers are proficient at processing these tasks faster [8]. Together, they are able to accomplish more than each could separately.

"Crowdsourcing" and "collective intelligence" are two terms that are frequently used to describe the activities and processes that players may use to help solve problems and support research through knowledge games. These terms also speak to the effective partnership between computers and human beings (and human-to-human interactions). Collective intelligence typically refers to the way that knowledge is shared among a collective of people, rather than just in one person's mind, suggesting that when people work together they can better solve problems and make more effective decisions [9]. Crowdsourcing which was first described by Howe, is "the process by which the power of the many can be leveraged to accomplish feats that were once the province of a specialized few" [10]. Since then, others have used the term to describe any collective activities done by human beings that are supported by technology, and the often mutually beneficial relationship among organizations and people that occurs when people (the crowd) are helping to solve this particular organization's problems [11]. For instance, a researcher or group of researchers may use a game to help crowdsource solutions, data, perspectives, or opinions related to a problem. Those researchers may be able to solve the problem or answer their research question more quickly and diversely because they are able to delegate the tasks to a wider range of people than their own lab or organization may be able to sustain. Moreover, a group of people with varied expertise may even be better at solving a problem or offering insight into a research problem than the individual researcher or lab [12].

In this workshop paper I explore a possible taxonomy for games for research and deeply dive into one subtype of these games—knowledge games—or games that are created specifically to solve real-world research questions using crowdsourcing, collective intelligence and human computation techniques. I also identify the next steps going forward.

1.1 Previous Typologies

To propose a possible new typology, I first investigated other related typologies. The first is by Brabham [13] and describes four approaches to crowdsourcing. Brabham's typology focuses on the types of problems crowdsourcing hopes to solve, and focuses on the perspective of the organization that is initiating the crowdsourcing activity. The typology is summarized in Table 1 and involves four types: knowledge discovery and management; broadcast search; peer-vetted creative production; and distributed human intelligence tasking. One issue with Brabham's typology is that it "conflates the goals or problems that are trying to be solved using crowdsourcing with the way that the organization or the public participates" [8]. In other words, it does not dive into *how* the people interact, and instead focuses on the goals of those interactions.

Table 1. Brabham's Crowdsourcing Typology

Category	General Approach	Examples
Knowledge discovery and management	Answers to research questions and open problems already exist out there in the collective public and the crowd can bring it forward and share it through a crowdsourcing platform.	Brabham uses SeeClickFix and Peer to Patent as examples of this approach [13]
Broadcast search	One person in the crowd has the answer to an open problem or research question and the crowdsourcing platform will be able to find it.	Brabham uses InnoCentive as an example [13]
Peer-vetted creative production	The public will design and curate new ideas, research possibilities, or products.	Brabham uses Threadless as an example [13]
Distributed human intelligence tasking	The crowd participates by analyzing data, collecting data, and doing other tasks to support research and other activities.	Brabham uses Amazon's Mechanical Turk as an example [13]

Another possible typology is from Wiggins & Crowston [14] and focuses on citizen science. "They criticize earlier citizen science typologies as focusing on how the public participates in aspects of scientific research, rather than… 'sociotechnical and macrostructural factors influencing the design of the study or management of participation'" [6, quoting 14]. Thus, in Wiggins and Crowston's typology, they categorize by project goals (e.g., education, conservation) and how projects may have clusters of different goals. The goals that emerged from their analysis are: science, management, action, education, conservation, monitoring, restoration, outreach, stewardship, and discovery [14].

1.2 Possible Typologies

There are many different ways we could categorize games for research. For instance, we could first separate games by whether the game is specifically made to solve research questions, versus whether a game is made primarily for other purposes, but could be used for some type of research. We could also organize the games by genre, platform, audience, commercial versus educational, and other typical typologies of games. While these types of organization may work on the macro level, they focus more on the goals and/or nature of the game itself, rather than its relationship to research and understanding the world. If we wanted to focus more on categorizing based on research possibilities, we could organize games by the type of research question or methodology used (empirical, qualitative, ethnographic), the epistemological lens (how do they answer questions and seek truths?), or by the type of knowledge or discipline advanced, such as humanistic, scientific or science, technology, engineering, and mathematics (STEM), artistic or aesthetic knowledge, or sociopolitical or social scientific. However, such disciplinary boundaries are artificial, and many research questions require multiple disciplines and types of methodologies to respond to them, further problematizing this type of categorization scheme.

We could categorize games by the scope of their research questions (local or global; school or type of community), or their ultimate research agenda, such as for community-building, policy-making, or education. We could also categorize by the type of researcher/research organizer who is using the game, such as corporate, non-profit/not-for-profit, college/school. However, for all of these divisions, there are overlaps and the organization and research project agenda may not be relevant to the type of research being performed.

We could also organize these games by the design principles that they use, game mechanics, design model used (e.g., Mechanics-Dynamics-Aesthetics (MDA)), or the types of social arrangements and techniques they may use to solve problems or respond to research questions. These are potential drivers of a typology; however, not all games are created specifically for research purposes. Thus, we may first need to divide games broadly into three main categories. These three categories relate to general categories by which games can be used for research purposes, even if those are the primary use of the game.

1. Commercial Games Research. Commercial Games Research includes commercial off-the-shelf (COTs) games that are used as "research laboratories" to learn about human nature, social interactions and other pursuits. This category could then be subdivided into research that is made publicly available or conducted and shared with the public to enhance our communal knowledge; and research that is generated and used only by the private sector for their own purposes (such as insight into their audience or to generate further profit and engagement). For instance, earlier I discuss Schrier's use of *Fable III* to research ethical decision-making [3], or Lofgren & Fefferman's use of *WoW* to research epidemiological models [1].

2. Educational Games Research. Educational Games Research includes educational games that are used to research their target population for educational purposes and assessment. (Note: not all educational games are made for these purposes; however, like the commercial games research category, this category includes games that *could be* used for this purpose). For instance, a game like the *DragonBox Numbers* series might be used to get feedback on a student's progress in gaining numeracy skills by evaluating how they are playing the game, and using this to gain insight into their learning process. Such a game may even learn about and assess an individual's growth, needs, and current understanding of a topic (something that *Fasttmath* does); or such a game could, in aggregate, be used to research and assess learning in a population or community, or across distance and over time.

3. Knowledge Games. Knowledge Games are games that are primarily and explicitly created to research a topic and build new knowledge in a domain. These games can be shared publicly or privately. For instance, *Foldit*, *EteRNA*, *SchoolLife*, and *Stallcatchers* are all examples of games that are primarily created to solve real-world problems and contribute new knowledge. To drill down deeper into the Knowledge Games category, I also considered the previously described citizen science and crowdsourcing typologies and considered how we could further subdivide knowledge games (and potentially the other categories). The resulting proposed typology was created with the purpose of initiating a conversation on these types of games. This typology will need to be further vetted empirically once more games for research, and knowledge games specifically, emerge. Any typology used should adapt to new uses of games. For instance, in the future, new categories may emerge, or any current categories may split further into subcategories. (See Table 2 for the possible typology of knowledge games, which was adapted in part from Schrier's book *Knowledge Games* [6]; see Table 3 for a list of games discussed in this article).

4 NEXT STEPS

Using games for research purposes may span several categories and we may not be able to capture their complexity with a simple typology or categorization scheme. However, creating a possible categorization scheme helps to understand the types of games that have been created, and also the types of games that could be created and the gaps that exist. One category of "games for research" is not better than another category and each game should be designed and matched to the research needs and goals of a particular research question and audience. Moreover, any categories that become widespread nomenclature should not proscribe the types of new games that are created, nor how they are used. Rather, any typology should serve to capture a moment of time in games for research and should evolve and adapt as needs, questions, technological abilities, and human interactions change. The next steps in evaluating these typologies include systematically and empirically analyzing and organizing all current knowledge games, and also all games for research, based on a number of different elements (such as goals, approaches, design principles, interactions, gameplay, audience), and then analyzing future games to understand and identify if any gaps remain.

Table 2. Schrier's Proposed Knowledge Games Typology

Category	General Approach	Examples
Cooperative contribution	These games invite players to contribute a task, such data collection or categorizing objects, to support a research agenda.	*Happy Moths; Reverse the Odds*
Analysis distribution	These games invite players to provide perspectives, interpretation or analysis.	*Apetopia; VerbCorner*
Algorithm-construction	Players engage in complex interactions to "teach a computer" (and us) more about humanity; it may also support the creation of an algorithm that a computer can better process.	*Foldit; The Restaurant Game; Which English?*
Adaptive-predictive	These games take the information and interpretations collected; and/or the way a player plays a game, and learns about the player(s) (individually and in aggregate) such that it can make predictions about that player and people more generally, and perhaps even adapt to better support the player. Note: this subcategory could become absorbed in the Algorithm-construction category insofar as a game's algorithms are then used to predict and adapt to the player.	*SchoolLife* approaches this but currently no game does this. However, many other types of games adapt to the player (such as *Fasttmath*, *Forza Motorsport*).

Table 3. A Selection of Games Discussed

Game Title	URL	Summary
DragonBox Numbers	http://dragonbox.com/products/numbers	Game that teaches numeracy skills. (DragonBox)
Foldit	https://fold.it/portal/	Players solve protein puzzles. (University of Washington/Center for Game Science)
EteRNA	http://www.eternagame.org/web/	Players design new RNA molecules. (Carnegie Mellon/A. Treuille)
Eve Online Project Discovery	https://www.eveonline.com/discovery/	Players do real-world tasks such as galaxy identification to earn rewards for Eve Online, a long-running MMO (CCP Games)
SchoolLife	http://www.giantotter.com/schoollife/	Players interact with bullying scenarios. (Giant Otter)
Beanstalk	http://www.tiltfactor.org/game/beanstalk/	Players transcribe text from (OCR) botanical book images. (Tiltfactor)
Fasttmath	http://fasttmath.mhs.org/slms/studentaccess/fmng	Players learn basic numeracy skills and the game adapts to the student's needs. (Scholastic)
Stallcatchers	https://stallcatchers.com/main	Players identifying and tagging structures in cellular images related to Alzheimer's Disease. (EyesonAlz)

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