# Citizen Science, Gamification, and Virtual Reality for Cognitive Research

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## Introduction

This workshop discusses three distinct but related topics. The first topic is *citizen science* which involves volunteers all around the world generating data to address scientific problems and recently led to breakthroughs in the natural sciences. Citizen science typically involves volunteers playing online games while unknowingly solving real scientific problems. This approach can benefit cognitive research either indirecty – if volunteers implicitly solve computationally hard research problems disguised behind a game – or it benefits researchers directly – if players do experimental tasks, with the key benefit that online games are easily accessible for a diverse international subject pool. Also, the data from existing citizen science projects provide insights for cognitive scientists (e.g., one citizen science project involved classification of galaxies). Although citizen science data is limited with respect to precise experimental control, its benefits are worth discussing.

Our second topic is *gamification,* which citizen science often relies on. Gamification, in general, involves adding game-like features to a task and could involve, for example, adding levels, points, or virtual characters to an experimental task. Gamified tasks are typically motivating for participants. While citizen science often uses gamification, also traditional laboratory studies can be supplemented with game-like elements and use technology from the gaming industry.

Our third topic is *virtual reality (VR).* This technology developed by the gaming industry enables players, equipped with a headset, to experience a controlled 3-dimensional environment that emulates being in the middle of a 3D scenario. Virtual reality typically causes subjective immersion by simulating a naturalistic experience of interacting with the world, while simultaneously offering full experimental control about the environmental structure and interactions. The link between (large-scale online) citizen science and (smaller-scale lab-based) VR research lies in that usually both approaches use gamification.

How can cognitive scientists use gamification and virtual reality environments for their research?

## Goals and Scope

This workshop brings together experts from the natural and social sciences who have successfully launched citizen science platforms as well as gaming researchers and game developers from different disciplines. The aim is to introduce citizen science to cognitive psychologists, stimulate a discussion about similarities and differences between laboratory and citizen science data, and explore the potential of existing citizen science platforms and data for cognitive research. A further goal is to gain insights into how best to conduct citizen science projects using gamification. Moreover, the workshop will explore the potential of virtual reality environments, fleshing out the challenges and opportunities of this novel technological opportunity for research. By the end of the workshop, all participants and speakers, will have been introduced to citizen science platforms, including how and where to run citizen science projects. They will understand the advantages and drawbacks of games for cognitive research, including an accessible way to design online applications. Lastly, the participants will have the knowledge to understand when and how virtual reality environments can be used to answer cognitive research questions in novel ways.

## Target Audience

The workshop targets researchers at all levels with an interest in investigating domains like problem solving, learning, attention, or decision making in settings suitable for interactive, gamified, or web studies. Note, that citizen science cannot offer maximum experimental control. Research interested in gamification in any form—offline or online—with a special focus on gamified experimental design and virtual reality are welcome. In particular researchers interested in cross-cultural data may be interested, as citizen science offers unique opportunities for international data collection. We also invite researchers interested in using virtual reality devices in the lab, and discussing its potential for cognitive research.

## Format

The full-day workshop involves short talks, hands-on experience with several of the games developed by the invited speakers, and the possibility to try out a task in virtual reality (using a HTC Vive). There will be two round table discussions. The first discussion focuses on the potentials and disadvantages of gamification and online data compared to laboratory data; the second discussion asks which of cognitive sciences' research problems can be fruitfully advanced by implementing the study within a virtual reality environment.

# Contributions

### Introduction of Concepts

**Jana B. Jarecki**, cognitive scientist at Basel University, will introduce the concepts citizen science and gamification.

**Jacob Sherson**, who has pioneered citizen science in quantum physics, will discuss how the citizen science platform *ScienceAtHome*, aims to exploit the clear mathematical framework of quantum physics and other natural science research challenges. This enables the construction of a suite of games bridging low-dimensional model challenges with complex relevant problem solving. He will also discuss the aim to turn ScienceAtHome into a large-scale social and cognitive science research platform offering insights into the individual minds and collective interactions.

**Pinja Haikka**, researcher at Aarhus University and head of outreach at ScienceAtHome, will talk about how to set up citizen science projects, with a special focus on *QuantumMinds* a citizen science project bridging quantum physics challenges and individual learning of volunteers participating in citizen science games.

### Where Citizen Science meets Cognitive Science

**Ed Manley**, who studies navigation skills with citizen science, discusses the *Sea Hero Quest* project, one of the most successful citizen science games in recent times. Originally developed to study navigation skills for dementia research, this project offers data on human navigation abilities from worldwide players from all age groups.

**Carsten Bergenholtz** from Aarhus University will introduce the *Alice Challenge*, a remote access experiment where volunteer players could remotely access and modify the settings of an actual instrument in the physics lab at Aarhus University. He discusses the challenges of remote experimental setups and discuss the advantages of running social science experiments on high-dimensional, real-life problems.

**Oana Vuculescu**, from the University of Aarhus, will introduce a game-based research project, the *AlienGame*, a sequential problem solving task to study the heuristics that individuals use in problem solving

### Designing and Building Games

**Juho Hamari**, is a Professor of Gamification (Associate & tenure-track) and leads the Gamification Group spread across Tampere University of Technology, University of Turku and University of Tampere in Finland. He will give an overview about the academic literature on gamified crowdsourcing.

**Nathaniel D. Phillips**, cognitive scientist at the University Basel introduces the R Shiny platform as an easy yet powerful tool to build online experiments and games directly from R code. Through shiny, web application can directly interface with R which enables the researcher to conduct dynamic experiments in which the user interface is determined by cognitive modeling running behind the scene.

**Julia A. Bopp**, PhD candidate and player experience researcher at the Human-Computer Interaction Lab at the University of Basel, will introduce what game aspects may evoke emotions and in turn how these emotions may influence good player experience.

**Sharon T. Steinemann,** PhD candidate at the Human-Computer Interaction Lab at the University of Basel, discusses meaningful game experiences. Her work investigates how in-game interactions shape experiences into being moving, thought-provoking, and personally meaningful. Findings and implications will be discussed using examples from current games with a focus on the relationship between game experiences and behavior change.

**Julian Jarecki**, virtual reality gaming developer at the University of Freiburg, introduces virtual reality with *GraphVR* and *Ultimate Automizer*. GraphVR is a virtual reality environment in which people can dynamically create and interact with near-real three-dimensional visualization of graph structures. The presentation will explore how VR creates an exciting opportunity to experience abstract concepts and structures.

**Libby Heaney**, virtual reality artist and research tutor at the Royal College of Art, will present a different way to use virtual reality, namely in the form of an exhibition that explains complex scientific matters to laypeople and makes these matters graspable.

### Hands-on Experience and Discussions

**Experience Virtual Reality.** We will additionally offer participants of the workshop the opportunity to directly experience and try out how virtual reality environments feel. We will have a live demo of Graph3D and other virtual reality environments.

## Invited Speakers

**Jacob Sherson** | Professor of Physics and Astronomy, Aarhus University | Founder of the citizen science platform ScienceAtHome

**Juho Hamari** | Professor of Gamification, Tampere University of Technology and University of Turku

**Carsten Bergenholtz** | Associate Professor of Management, Aarhus University

**Ed Manley** | PostDoc in spatial cognition, UCL London | Partner at the citizen science project SeaHeroQuest (*tbc*)

**Julia A. Bopp** | PhD candidate, gaming researcher, University of Basel

**Julian Jarecki** | app and gaming developer with focus on development in VR, University of Freiburg

**Libby Heaney** | Digital and virtual reality artist and tutor at the Royal College of Art London

**Nathaniel D. Phillips** | PostDoc in cognitive science, University of Basel (tbc)

**Pinja Haikka** | PostDoc in Physics, Aarhus University | Head of Outreach at ScienceAtHome (tbc)

**Sharon T. Steinemann** | Phd Candidate | University of Basel