



Validation of a social media quiz game as a measurement instrument for climate change knowledge[☆]



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ABSTRACT

For effective public communication about climate change, survey data on laypeople's climate change knowledge is crucial. However, international survey programs are costly in terms of time and money. Alternatively, games with a purpose may provide data on their players' knowledge at minimum effort, unobtrusively, and repeatedly within short time intervals. The present study confirms game statistics from the social media game Climate Quiz to measure climate change knowledge. Players succeed in the game if they identify the same ontological relations between terms on climate change topics as most co-players. Drawing on game data of 193 players, the game point score is established to reflect climate change knowledge with sufficient accuracy to be utilized in the social sciences and in climate communication. The point score shows satisfactory reliability, criterion validity referring to conventional quiz questions as well as expert judgments, and discriminant validity regarding psychological attributes related to knowledge. The current player collective consists of young, highly educated and environmentally conscious players though, thereby representativeness of game scores for the general population is still limited.

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1. Introduction

Climate change is a serious threat to ecosystems and societies. While the scientific community widely agrees on forecasts and implications of anthropogenic climate change [1], these topics do not equally well disseminate to the general population, leading to public indifference or skepticism. Knowledge has been shown to shape cognitive and affective risk perception of climate change [2] and has been related to individual assessments of threat by climate change [3–5]. Information can make the impacts of climate change salient to laypeople and may direct their attention to non-obvious hazards that have not yet reached disaster proportions [6]. Accurate knowledge supports public acceptance of government initiatives to combat climate change [3,7,8], but does not necessarily translate directly into changes in household energy conservation [9–11]. To instigate deliberative processes on climate policy actions, policy communicators need to assess the current level of information and need to identify widespread misperceptions among citizens. Public awareness-building campaigns are currently impeded by fragmentary data on the level of laypersons'

knowledge regarding the causes and expected impacts of climate change.

Data on individual knowledge regarding climate change in the general population is hard to obtain. The collection of international and intercultural data demands considerable effort in time and money: Interviewers must be paid, interviewees must be approached and engaged to participate, and data entry must be coordinated. Surveys like the International Social Survey Programme, the World Values Survey or the Eurobarometer provide results for numerous countries, but are expensive to conduct, limited in the scope of topics they can include, and provide data in large timeframes of 1–5 years. For example, the International Social Survey Programme investigated the topic 'Environment' in the years 1993, 2000, and 2010 [12], leading to long periods in between where no current data on public opinion regarding this topic was available. Detailed knowledge surveys are usually one-time endeavors limited to single countries (e.g., [13] for the United States, or [8] for Switzerland).

Serious games might provide an alternative instrument for obtaining data on citizens' climate change knowledge. Serious games are not just designed for the purposes of fun and recreation like other games, but also to engage players in learning and problem-solving, thereby addressing real-world policy issues [14,15]. They are unique in harnessing the players' intrinsic motivation

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and curiosity outside a tedious classroom context. Several serious games for environmental education have been successfully launched for adult and child audiences, such as the BBC's Climate Challenge or the NASA Jet Propulsion Laboratory's Climate Kids program. Volunteers have shown considerable willingness for online collaboration, most notably in Wikipedia, but also in various serious game applications [16]. Games with a purpose, as a subcategory of serious games, are characterized by engaging players in simple computational tasks that can be solved better by human common sense than by computer algorithms [17,18]. In a parallel development, casual web games have emerged in recent years which can be played in between work or leisure activities, partly in interaction with friends. As widespread media, casual games facilitate access to large population segments.

By means of casual games with a purpose, social scientific data may be collected (1) at low cost, as the numerous users of social media platforms can be approached for extensive samples, and the players are motivated by the game's incentive mechanism; (2) unobtrusively, as players are not self-aware of being surveyed; and (3) continuously, as the tracking of player IDs allows to gain repeated measures from the same individuals. As a first step to these goals, this paper presents the game with a purpose Climate Quiz and shows that the game score indeed reflects climate change knowledge, therefore providing an innovative alternative for measuring the level of knowledge in the general public.

The following Section 2.1 introduces principles and incentives of the game, and argues the underlying 'wisdom of the crowd' approach. Section 2.2 presents the rationale for verifying the game score as a measure of climate change knowledge. The method Section 3 describes the sample of test players as well as calculation of relevant indicators: the game score, quiz questions as an external measure of knowledge, and related psychological factors in a small subsample. Section 4 presents results on representativeness, reliability and validity, which are discussed in regards to future potentials of games with a purpose as a source of social data in Section 5.

2. Present study

2.1. Game design

Climate Quiz was developed complementary to the Media Watch on Climate Change ([19,20]; <http://www.ecoresearch.net/climate>). The Media Watch enables structured access to text resources on climate change, such as research papers, news media and social media coverage, by applying web-based text mining technology. Relevant documents from multiple sources are gathered and annotated automatically. However, to classify the documents by topic, a preliminary ontology describing how relevant terms relate to each other needs to be refined.

2.1.1. Game tasks

This refinement is done through a collaborative effort within Climate Quiz, by deconstructing ontology building into small tasks that can be solved by the player collective. A game task consists of a pair of terms related to climate change (e.g., keywords like 'methane' and 'greenhouse gas'), for which the player has to choose the most appropriate relation (e.g., 'is a subcategory of'). Eight relations are available: is identical to, is a subcategory of, supports, threatens, opposes, influences, works on/with, is not related to. Game tasks are randomly selected from a pool of over 1200 term pairs covering topics from climate policy and climate research. A player does not receive the same game task twice.

Players proceed in the game by correctly identifying the same ontological relations as the majority of co-players. Following the 'wisdom of the crowd' paradigm, the ontological relations

commonly agreed on are assumed to be correct, thereby validating and extending the Media Watch's original ontology.

2.1.2. Is the 'wisdom of the crowd' correct?

The approach of several players agreeing on a common meaning has already been successfully applied in games with a purpose for image labeling [17] and for text annotation [18,21]. However, one might doubt whether the opinion of a lay majority indeed reflects the true ontological relations, as they would be determined for example by experts.

Surowiecki [22] and other authors [16,18,23] argue that the collective opinion of laypeople delivers a judgment of similar quality as the deliberations of experts, provided the laypersons decide autonomously and have diverse personal backgrounds. In addition, experts do not always perform better than laypersons. Regarding assessments of ecosystem risks [24] report similar levels of disagreement among experts as among laypersons, and [25] find little evidence that experts are more veracious than laypeople. Regarding semantic relatedness of word pairs, a topic comparable to the game tasks in Climate Quiz, [26] find that the wisdom of the crowd is at least competitive to the wisdom of linguist experts.

Siorpaes and Hepp [18: 50] underline that ontology building as a shared representation cannot be done by a solitary group of experts, but is by its "very nature [a] community effort – humans must interact to yield useful results." Above and beyond, it is debatable whether an objective and unique ontology even exists or whether an ontology evolves dynamically through public discourse, and only the massive manpower of laypersons makes keeping track of these changes feasible.

In Climate Quiz, there are no explicitly correct or false responses to game tasks, but only responses which do or do not match the opinion of the majority of players. However, assuming that the wisdom of the crowd is correct, an individual player's ability to anticipate the majority view might in part reflect his actual knowledge.

2.1.3. Game points

For the purpose of this paper, the point score, the by-product of the game is analyzed, not the player-generated ontology.

Playing the game, participants earn one point for a matching response, but also lose one point if their opinion differs from the majority of other players. If unsure about the correct answer, players may skip a game task without benefit or penalty. The in-game notification system compares the current game point score (1) to the top score, (2) to the scores of the player's friends, and (3) to the scores of other competitors with scores close to the player. Thus, real-time feedback on the participants' progress compared to other players is given (see Fig. 1). When inviting friends to Climate Quiz, players earn 10% of the points a friend makes after accepting the invitation as a bonus. Game scores are reset to zero every month in order to encourage later newcomers to join the competition.

2.1.4. Quiz questions

Between the game tasks of choosing the appropriate ontological relation to a term pair, quiz questions are interspersed. Quiz questions are given in random order during the initial stage of the game, so that every second game task is followed by a quiz question. In contrast to the 'wisdom of the crowd' criterion for gaining points in game tasks, all quiz questions have just one predefined correct answer (see Section 3.3). Similar to game tasks, players gain one point for answering correctly, and lose one point for a wrong response. Once all available quiz questions are answered, players receive an invitation to complete an online questionnaire worth 50 additional points.

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