Games to Collaboratively Explore Environmental Complexity: Designing the Virtual River Game [1]

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Background

Worldwide, there is an increasing need to respond to societal and environmental challenges that are generally characterized by their inherent complexity and uncertainties, effects on multiple spatial and temporal scales, and the need for multi-stakeholder decision-making that crosses disciplines. To support decision-making, serious games are increasingly developed and applied as tools that aim to support players in collaboratively exploring such challenges and possible solution strategies to address them, particularly in environmental management and urban planning.

Knowledge gap

The interest in serious games has largely been fueled by advances in computational power and in the gaming industry; designing games as collaborative environments to effectively support multidisciplinary, multi-stakeholder decision-making has not occupied center stage in serious game development.

Research aim & Virtual River Game case study

We proposed to research the needs and desires of actual stakeholders in societal and environmental challenges and to make their needs and desires the starting point of a serious game's design process by applying a human centered design process. The main aim of this research was therefore: *to explore how a human centered design of serious games contributes to foster exploring complexity, facilitating stakeholder participation and stimulating social learning in environmental management.* To do so, the research on and design of the Virtual River Game served as a case study.

The Virtual River Game was developed to be a tool to support participation following a paradigm change in Dutch river management that shifted focus from dike strengthening to so-called spatial measures and multifunctional design. By involving actual river management stakeholders during the game's design process [1, Chapter 2], we found that some stakeholders – particularly those not usually involved in river management before the paradigm change – viewed the hydrodynamic computational models that are used to substantiate decision-making as black boxes.

Drawn to the face-to-face interaction that characterize board games, we developed a novel, hybrid interface (Figure 1) that uses a physical board as a tangible user interface to a hydrodynamic and other sophisticated computational models, enabling players to collaboratively work directly with these models during gameplay, regardless of their background or expertise [1, Chapter 4]. The game board uses a hexagonal tile-based grid as a representation of a fictional but typical stretch of a Dutch river. Each tile is filled by a combination of two modular types of game pieces that represent elevation and land use separately. Information on each tile's elevation and land use is converted to a digital elevation model and land use distribution, which are used as input for among others Delft3D-FM and BIOSAFE; sophisticated computational models that are widely used in the water domain. Output of these models is visualized on the game board through projection to create a perceptual coupling between the players' actions the models' output.

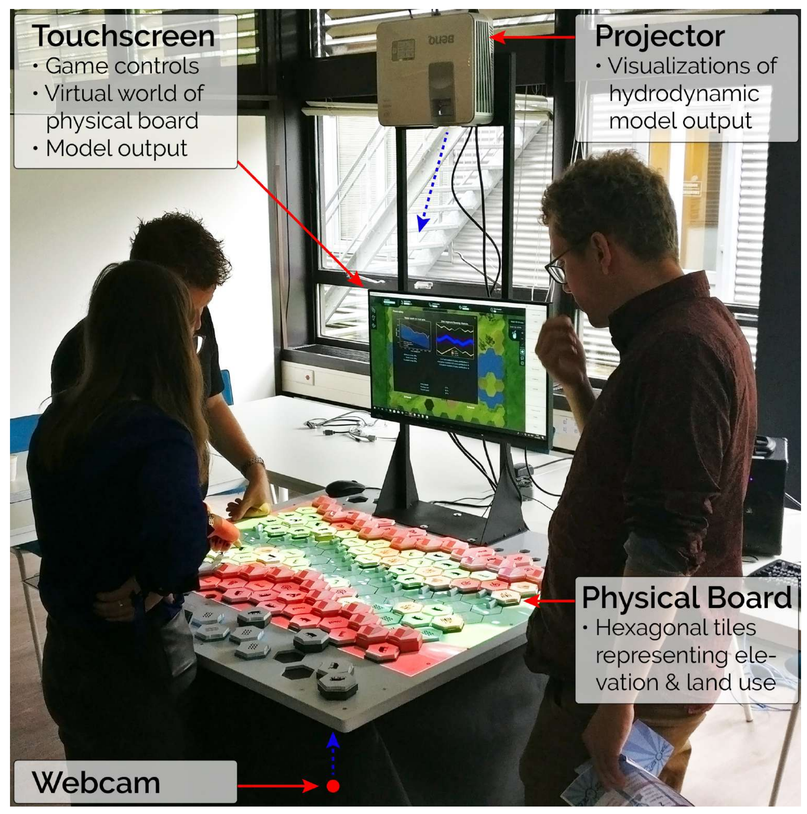

Figure 1. An impression of the hybrid interface, including the physical board, touchscreen monitor, projector, and webcam.

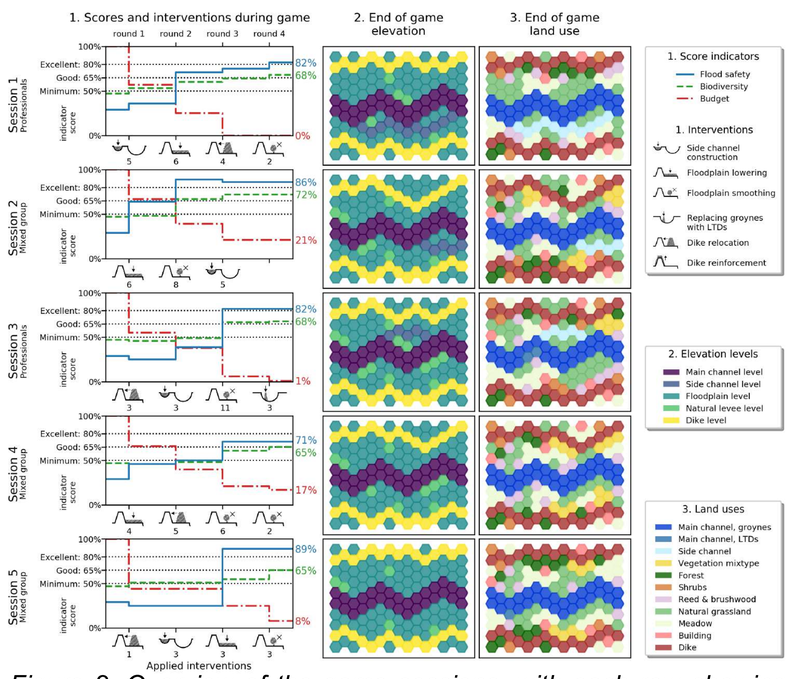

Figure 2. Overview of the game sessions, with each row showing the result of one session. The first column shows the interventions and number of different implementations applied during the four game rounds and the resulting progression of indicator scores, with the final indicator scores listed to the right of the graphs. The second column shows the final board layout for the bed elevation and the third column shows the final layout for the land use.

Virtual River Game [1, Chapter 5]

We set out to develop the Virtual River Game as a tool to increase and support stakeholder participation. The game can beneficially be played as an icebreaker activity that is disconnected from a river project's actual decision-making. In the game, players are challenged to improve the flood safety and biodiversity of a deltaic stretch of river while not exceeding the budget.

The game was played with 15 domain experts and 11 non-experts in five sessions. Data was gathered using a multi-method approach [1, Chapter 3] that included: (1) a pre-game questionnaire; (2) in-game data logging (Figure 2); (3) in-game observations; (4) a post-game questionnaire (Figure 3); and (5) a post-game debriefing. Results from the sessions showed that the game: (1) successfully enabled experts and non-experts to collaboratively explore and experiment with river interventions; and (2) led to learning outcomes for both experts and non-experts, albeit to different extent and with different emphasis.

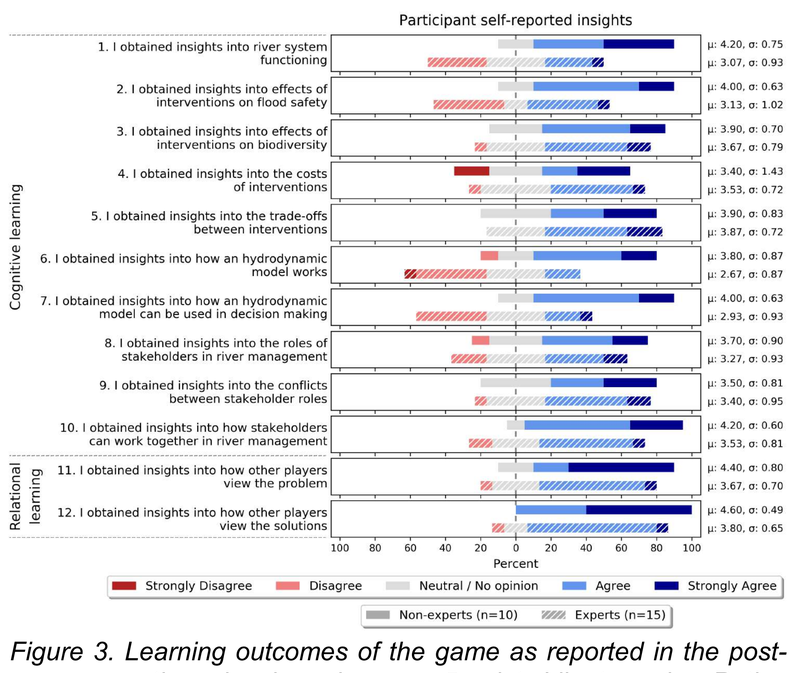

Figure 3. Learning outcomes of the game as reported in the post-game questionnaire based on a 5-point Likert scale. Rating strongly agree counts as 5; strongly disagree as 1. The statements relate to the functioning of the river system (1), the effects of interventions and their trade-offs (2–5), how hydrodynamic models work and are used in decision-making (6–7), the roles of and conflicts between stakeholder roles (8–10), and the views and perspectives of other players (11–12).

Four main contributions of the research [1, Chapter 6]

1. Applying a human centered design process to the design of serious games, which led to;
2. Developing a novel, hybrid interface design that uses a physical game board with a bidirectional link to sophisticated computational models to make these models both accessible and transparent to players;
3. Adding the ability to experiment with the design of interventions using tangible game pieces as a game mechanic over selecting predefined interventions; and
4. Creating the interface as a platform through which the Virtual River Game can be customized and new serious games with a spatial component can be developed.

Acknowledgements

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[1] den Haan, R.J. (2020). Games to Collaboratively Explore Environmental Complexity: Designing the Virtual River Game. University of Twente, Enschede.

RiverCare
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