Finding the Game in Decision-Making: A Preliminary Investigation

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Abstract
In this paper, we argue that decision-making is at the core of what games are. Framing the use of gaming from a decision-making perspective, interactivity is about being able to make decisions and agency about being able to make meaningful decisions, that is, decisions that have perceivable consequences in the game environment. The central hypothesis of this paper is that if gaming is about decision-making, then gaming is useful to research decision-making. We expand on this hypothesis by mapping the roles that gaming might have for decision-making with a framework from the decision sciences that distinguishes work into normative, descriptive, and prescriptive approaches. We conclude two main roles: the use of gaming as a research method ('learning from') and the use of gaming as an educational tool ('learning through'). We illustrate both roles with two distinct cases and discuss additional steps necessary to continue to find the game in decision-making.

Keywords: decision sciences; decision-making; research methods; learning.

1. Introduction

Playing games is about making decisions. The well-known game designer Sid Meier once defined games as "a series of interesting choices" (Rollings & Morris, 2000, p. 38). In his definition, Abt (1987) explicitly referred to players as decision-makers: "reduced to its formal essence a game is an *activity* among two or more independent *decision-makers* seeking to achieve their *objectives* in some *limiting context*" (p. 6). Being a decision-maker and making choices is what sets games apart from other activities. The ability to influence the activity relates to the notions of *interactivity* and *agency*. Crawford defined interactivity metaphorically as "a cyclic process between two or more agents in which each agent alternately listens, thinks, and speaks" (p. 29). One of the agents can be the computer (or the 'accounting system' in more traditional gaming-simulations, see Duke & Geurts, 2004). A computer receives input ('listen'), processes data and makes calculations ('think'), and displays output ('speak'). In the context of this paper, the terms listen, think, and speak can be considered steps that are part of a decision-making process that involves "two or more independent decision-makers."

Murray (1997) defined agency as "the satisfying power to take meaningful action and see the results of our decisions and choices" (p. 126). This suggests that interactivity is a necessary but not sufficient precondition for agency. Agency requires more than participation. Players need to be able to shape the activity. While not necessarily referring to agency, Church (1999) took Murray's conception one step further, using the concepts of 'intention' and 'perceivable consequence' (Wardrip-Fruin et al., 2009). He explains that making players know what to expect and making them feel in control is what encourages players to do things intentionally. The perceivable consequence is a "clear reaction from the game to the action of the player." Combined with intention, perceivable consequence will help players come to understand the world of which they are part. Wardrip-Fruin et al. (2009) elaborate that agency is not "free will" or "being able to do anything." Agency involves both the game and the player and occurs when the actions players desire are among those they can take as supported by an underlying computational model. This view on agency re-affirms Crawford's definition on interactivity, where one of the agents is the 'computational model' that drives the gameplay, and specifies the meaning of the ‘limiting context’ in Abt’s definition. Agency is acting within the affordances offered by the game. This leads back to Meier’s definition that emphasizes choices. The game’s affordances are presented as choices. They are ‘interesting’ when they result in perceivable consequences. In other words, decision-making in games is meaningful when agency exists, not just interactivity. Another term for agency might thus be ‘meaningful decision-making’ and this is exemplified by well-designed games (Wardrip-Fruin et al., 2009). Player actions should matter.

The aforementioned philosophical inquiry suggests that decision-making is at the core of what games are. We can frame games as ‘constrained and artificial decision-making environments’. In this paper, we hypothesize that if gaming is about decision-making, then gaming is useful for research on decision-making. We realize that games have been used for decades, if not centuries for decision-making, with the game of *Chess* as an illustrative example (Harteveld, 2011). Therefore, an abundant number of examples exist that highlight the usefulness of gaming for decision-making. However, until this very day, gaming is not a standard in the (applied) scientist’s toolbox and has not led to significant theoretical contributions on this topic. To actually prove the usefulness hypothesis, what is needed is methodological rigor, followed by strong empirical evidence on what we can learn about decision-making through gaming. In this preliminary investigation, we seek this rigor by considering an established framework from the *decision sciences*, an interdisciplinary field that is concerned with the study of decision-making. In our view, framing gaming within this established discipline will be one of the steps towards understanding the roles of gaming for decision-making and how it can contribute to the knowledge base on this topic. Within the decision sciences a distinction is made in the study of normative, descriptive, and prescriptive theoretical branches of decisions. We will elaborate on these three theories and illustrate, by means of two distinct cases, how games can be used to study decision-making under each branch. Our investigation ends by discussing how this effort could be broadened.

2. Roles of Gaming for Decision-Making

The decision sciences draw from works in economics, psychology, philosophy, engineering, mathematics, and statistics to gain insight into the phenomenon of decision-making. The first branch, *normative*, is concerned with finding the most optimal decision. It views decision-making in terms of the decision-making *event*, i.e. the choice between two or more alternatives (Klein et al., 1993). It further assumes that problems are well defined, information is structured, clear, and accessible, and decision-makers have complete information and act fully rational. *Game theory*, not to be confused with theories on games as media, is an approach that falls within this branch of decision science. By means of mathematical models, the social interaction between intelligent rational decision-makers is studied.

Decision-making in practice usually does not qualify the assumptions that the normative branch foresees. The second branch, *descriptive*, therefore describes what people actually do, through an empirical study of how people make decisions. Descriptive theories focus on decision-making that reflects biases, the use of heuristics, and other suboptimal decision strategies that individuals often employ (for an overview of normative and descriptive theories, see Hastie & Dawes, 2009). Another focus is on policy-making, where decisions are made in multi-stakeholder settings (Mayer, 2009). In contrast to the normative branch, decision-making in both descriptive foci is characterized as messy, ill-structured, and dynamic.

The third branch, *prescriptive*, is preoccupied with how people ought to make decisions. This branch is aimed at finding tools and methodologies to help decision-makers in making better decisions. This branch can be conceived as ‘applied decision sciences’ as it is concerned with how insights from the decision sciences can be used to improve existing practices. Collaboration Engineering and Decision Support Systems are examples of existing fields in this branch.

This framework distinguishing normative, descriptive, and prescriptive work, is useful to elaborate on the roles of gaming for decision-making. In terms of the normative branch, we would have to expect that players behave rationally, making this approach unrealistic in modeling the decisions of players. However, normative models are useful for designing games and for creating assessment frameworks. As for the design, normative models help designers in preventing players from making decisions that are always optimal (Juul, 2005). If a choice is always optimal, choices are not interesting (see Meier's definition). In addition, a normative model can be used to assess how players deviate from this, either by means of a score or feedback.

Unlike the normative branch, gaming could contribute to descriptive theories of decision-making. Although this use is not yet pervasive, this potential has been recognized:

> Computers are being increasingly used to create gaming environments and to present humans with varieties of experience in simulated settings and artificial worlds. All of these settings offer the potential for putting humans into cognitively complex and challenging circumstances in order to understand how we perform tasks, make sense of what is going on, act, and react (Crandall, Klein, & Hoffman, 2006, p. 19).

As the quote describes, researchers can use gaming as a method of inquiry for observing how people make decisions. What makes gaming interesting from a descriptive point of view is that it allows researchers to study how people make decisions in circumstances that are not possible in the physical world, such as during a disaster. Moreover, it allows for bridging the gap between normative and descriptive models. In the classical sense, experiments are tightly controlled, leaving out any possible external influence that could confound the results. In naturalistic settings, however, it is impossible for researchers to control the environment. Although games are artificial, they do allow researchers to place decision-makers in a believable setting over which the researchers have control. Therefore, with gaming, researchers gain the control that they have in laboratory environments while still enabling decision-makers to situate them in semi-naturalistic settings.

Although more commonly known as a medium for entertainment, gaming has gained widespread attention as a powerful educational tool in the past decade (Harteveld, 2011). In 2006, the Federation of American Scientists published a report describing the potential impact of games. They concluded that games may be especially effective in teaching higher-order skills such as decision-making because "in games, players are making decisions continually, in contrast to low levels of decision-making in traditional learning" (p. 43). Gaming can be seen as an educational tool to help decision-makers in making better decisions and is for this reason relevant to the prescriptive branch. Various efforts have been made in this direction (Harteveld, 2012).

Based on the mapping of gaming to the three core branches in the decision sciences, we can identify two main roles. The first is the use of *gaming as a research method*. In this role, researchers use a gaming environment to "learn from" how people make decisions. The second is the use of *gaming as an educational tool*. In this role, players will "learn through" a gaming environment. Both options can perfectly occur in the same environment (see also Meijer, 2006). It is also impossible to exclude one or the other. Players will always end up with an experience and researchers can always observe player behavior and retrieve insights from player behavior. However, designer intentions do matter and if a gaming environment is intentionally designed as a research method or educational tool, different trade-offs will likely be made (Harteveld, 2011).

Figure 1 provides an overview of the role of gaming for decision-making. It illustrates that, based on a certain problem from the physical world, we start with a design process where we have to decide first on our intentions and the role(s) the gaming environment will have. This design process will not lead to a 1-to-1 mapping of the physical problem. As part of the design process, abstractions are needed and trade-offs have to be made (Duke & Geurts, 2004, Harteveld, 2011). Deploying the game will result in various qualitative and quantitative data, based on observations and logs, amongst others, and these can be used for analysis of the object of investigation (e.g., player decision-making). By comparing the outcomes of the analysis to other data, the *validity* of the results can be guaranteed. Other methods are also possible, such as expert validation, but these are less convincing than comparing it to existing data sets. The resulting data can also be used to assess the players participating in the gaming environment. By using additional measures, researchers may be able to determine whether playing the game has resulted in an impact in the physical world, which is generally known as the concept of *transfer*.

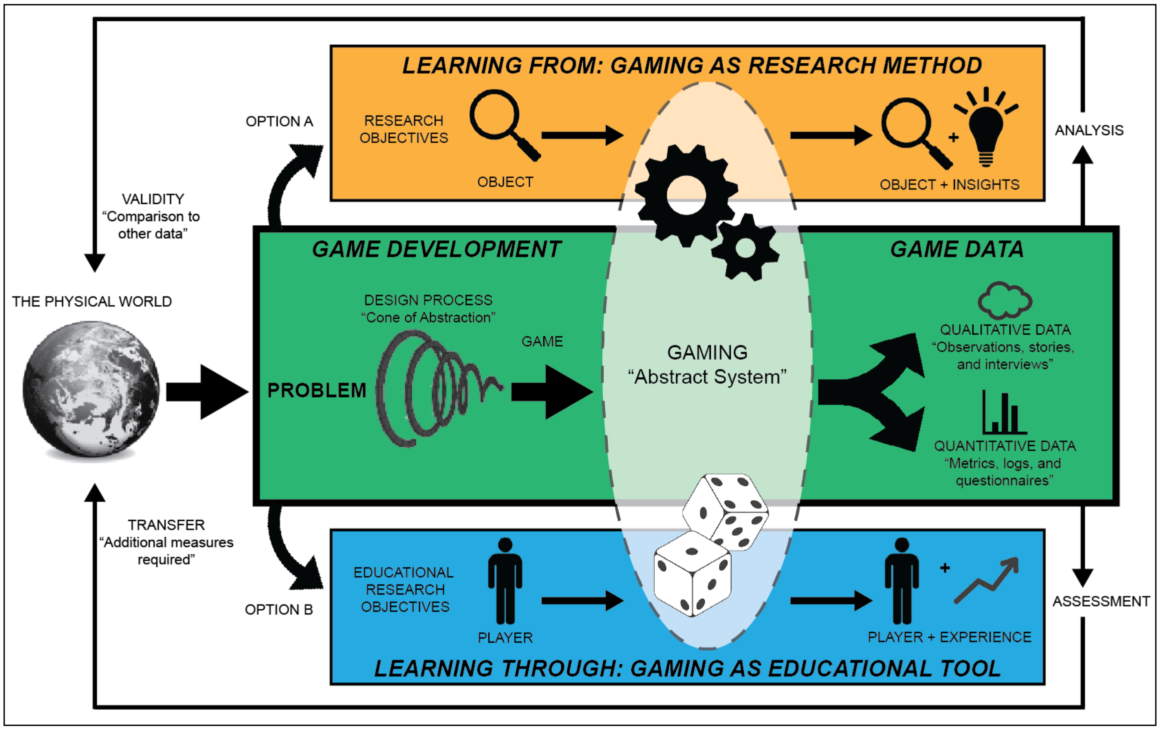


Figure 1: Overview of the two main roles of gaming for decision-making

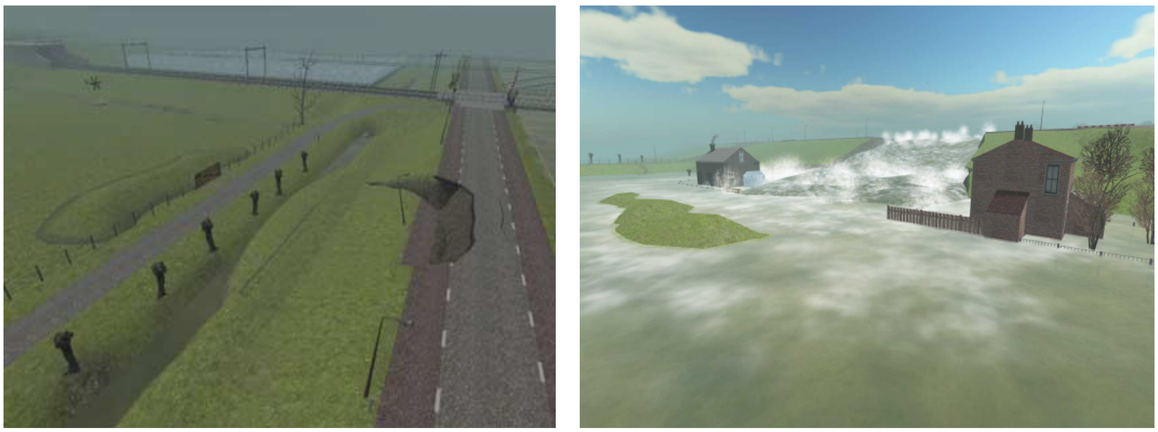
3. Cases of Gaming for Decision-Making

The previous may sound abstract. To illustrate the roles of gaming for decision-making, we present in this section two cases: the case of *Levee Patroller* and the case of *Orc Army Recruitment*. Both cases do by no means represent the entire potential spectrum for game research on decision-making. For example, both examples are single-player, first-person digital games and so illustrate a particular game type. Sharing the same baseline characteristics, however, does allow us to emphasize the differences in their roles for decision-making. It will become clear that both cases have applied gaming as research method and as educational tool, but in a different manner. *Levee Patroller* started off from being developed as an educational tool, whereas *Orc Army Recruitment* was initially developed as a research method.

3.1 Levee Patroller

Levee Patroller is a game where players can walk freely around a 3D environment – the purpose of the movement being to find all potential levee failures and appropriately deal with them using the tools of the game (e.g., handbook, map, etc.). Upon finding a failure, players have to recognize the failure, assess the entire situation, and take actions if needed. Failures can change over time, requiring players to return to the problem locations to determine if the potential failure worsened. If players do not appropriately deal with failures, a flooding results (see Figure 2). Throughout and at the end of an exercise, players receive feedback on how they performed.

Levee Patroller was developed as an educational tool for practitioners that have to deal with levee failures (prescriptive models). Playing the game will allow these practitioners to make decisions in a safe environment and learn from their mistakes. More importantly, this game is an exemplar of allowing people to make sense of phenomena that are difficult to observe in the physical world. An efficacy study (Harteveld, 2012) proved that the game was effective: after three weeks of training with the game, participants starting with limited practical experience perform as well as experts. Moreover, learning transferred to real world situations: participants made sense out of real pictures on a test just as well as on virtual ones. Learning was also engaging: 80% of the participants played almost all exercises and spent over 10 hours on the game-based training and enjoyed doing this. Therefore, *Levee Patroller* is an example that highlights the educational potential of using gaming as an educational tool for decision-making.



(a) Levee failure (b) Flooding

Figure 2. Two screen shots of the game *Levee Patroller*

Although the game was primarily targeted as an educational tool, the log data derived from the game allowed for an analysis of how players made their decisions (descriptive models, see Harteveld, 2012). In the context of *Levee Patroller*, this meant retrieving how players labeled signals and failures, how they assessed the situation, what actions they took, among others. Because players played multiple scenarios over the course of three weeks, it was possible to see how their decision-making changed over time. Some of the insights from this analysis were that players were careful in providing accurate reports, pragmatic in certain circumstances, and influenced by the context. Most striking was that players remained largely consistent and persistent with their original decisions. This led to the conclusion that the 'glass is half-full'. With better feedback, the educational outcomes of *Levee Patroller* might improve.

What is furthermore interesting is that the game uses a normative model for making decisions, which was developed in close collaboration with subject-matter experts (Harteveld, 2011). Due to limitations in software development, we were only able to identify one correct answer (or a range) for each possible input that the player provided, whereas in reality multiple answers can be correct. In the game, player decisions are compared to this normative model and are converted into a player score. This player score strongly correlated with test performance in the end, thereby showing validity. However, when discussing the various failures and the normative model associated with them, little consensus was found amongst a broader audience of experts. This brings up an intriguing design dilemma, which may likely re-occur in many other gaming environments. Whereas the real world may not provide for a normative model to assess player performance, a game environment needs to have one to translate player behavior to a score.

3.2 Orc Army Recruitment

Our second case is *Orc Army Recruitment*, a game that was used to study the decision process for the solicitation and implementation of expert advice (Sutherland, 2012). In this game, participants were asked to recruit an army of orcs by picking the best soldiers in various locations. As shown in Figure 1, the basic gameplay involved picking the best soldier among three orcs in a hut. There were 27 huts per level and 3 levels, giving each participant 81 decision points. A multinomial logit model was used to assign probabilities of being the best soldier to each orc (Luce, 1959):

$$\text{Probability Orc}_i = \frac{e^{\theta * \text{SizeOrc}_i}}{\sum e^{\theta * \text{SizeOrc}_j}}$$

In this study, Θ represents how predictive size is as a cue to the correct orc and was randomly determined for each participant. Each participant had access to an expert; however, the accuracy of the expert and cost of the advice (amount of time to wait for the advice) was randomized for each participant. When participants selected the best soldier, they were permitted to continue; however, if the best soldier was not selected, participants were sent to a timeout zone for 40 seconds. Thus, the normative approach to selecting whether to request advice was to determine how long the decision-maker would have spent in timeout, on average, on a given trial with and without advice, adding the cost of the expert into the calculation. If the time spent in timeout would be longer without advice, the participant should have solicited expert advice. This is the programmed model; however, participants did not make the normative decision on most trials.

Figure 3. Player's view in *Orc Army Recruitment*. This figure shows a sample trio of varying orc sizes and the expert's recommendation (arrow selectron).

The departure from normative decisions was expected. The research purpose of *Orc Army Recruitment* was aimed at describing how participants actually made their decisions and how those decisions departed from the normative model (descriptive models). The results showed that participants failed to integrate the environmental cue and the expert consistently and optimally (Sutherland, 2012). Once the best models were selected, reflecting under which circumstances participant decisions were sub-optimal, new studies, using the same platform, were possible for training participants to make more normative decisions. This coincides with the ultimate goal of the decision sciences, which is to facilitate better decisions (prescriptive models).

In fact, such a new study to teach individuals to make better decisions was implemented (Sutherland, 2012). Three levels were tested to determine how training experiences improved the integration of the environmental cue and expert accuracy to determine when advice should be solicited. Requiring participants to request advice on every training trial led to an overreliance on factors associated with the expert to determine when advice was requested. Providing no expert during training created an overreliance on factors associated with the environment in determining when to request advice on subsequent trials. However, requiring participants to request advice on odd trials and providing no expert on even trials led to a better integration of the environment and expert to closer approximate the normative model. This suggests that decision-makers should be trained in different contexts in order to make better decisions.

4. Discussion

In this paper, our goal was to explore the possibilities of gaming for research on decision-making, considering that gaming can be framed as a decision-making environment. We explained how gaming can be useful for decision-making, as a research method ('learning from') and/or as an educational tool ('learning through'), and illustrated these roles by means of two cases. Both cases resulted in valuable insights and provided empirical support that gaming can be used to study and improve decision-making. This resulting idea that gaming can be used to study and educate is not new (e.g., Meijer, 2009), is one that others are exploring too (e.g., Karl, 2014), and is not specific to this particular topic. However, our particular contribution is in framing the usefulness of gaming within the established discipline of the decision sciences. We conceive of this as one of the steps that will help to build methodological rigor and establish gaming as a standard in the (applied) scientist's toolbox for researching decisions.

Various reasons exist for why gaming is not a widely recognized methodology for pursuing research on decision-making. Proving validity is hard, due to the constrained and artificial nature of gaming environments. Isolating or manipulating variables is not impossible but will reduce the 'gameness' of gaming, which typically involves many variables and is subject to many confounding variables. *Orc Army Recruitment* is an example of a much more tightly controlled, and therefore constrained game environment than *Levee Patroller*. Another complicating factor with gaming is player behavior. Players may intentionally 'game the system' or in general exhibit different behavior than they would in reality. Problems will increase when considering multi-player games. Other than more difficult to design for (Harteveld & Bekebrede, 2011), such games give researchers less control and cause for additional confounding variables, such as group dynamics. There are many other factors that impede adaptation, but the most problematic ones are that much effort is required to design the environment, to implement the design, and to play it with enough players to run statistical analyses. For example, from the design to its evaluation, *Levee Patroller* took six years (Harteveld, 2012).

That said, advances in game technologies are continuing to make game development more efficient and affordable, making it increasingly more attractive for researchers to use games as a method for understanding human behavior. Although not suitable for every cause, online deployment and crowdsourcing have proven successful to attract multiple thousands of players (e.g., Cooper et al., 2010). These and other developments are indications that a paradigm shift towards a systematic use of gaming for decision-making (and other phenomena) is a possibility. In our view, to make gaming a widely recognized methodology as part of the decision sciences, the next step would be to perform a comprehensive review of what has been done before and interpret this in light of the values of the discipline. A second step would be to work out the methodologies in far more detail than what has been provided here. It is possible that additional frameworks, methods, and techniques from the decision sciences will help to improve the rigor, just as this has happened in the field of education (e.g., Kriz & Hense, 2006). A third step would be to gather game data and then find evidence for validity and transfer. We will continue to find the game in decision-making by considering these three steps, and we hope that through this paper others will join us in our journey.

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