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How Digital Strategy and Management Games Can Facilitate the Practice of Dynamic Decision-Making

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Abstract: This paper examines how digital strategy and management games that have been initially designed for entertainment can facilitate the practice of dynamic decision-making. Based on a comparative qualitative analysis of 17 games—organized into categories derived from a conceptual model of decision-making design—this article illustrates two ways in which these games may be useful in supporting the learning of dynamic decision-making in educational practice: (1) Players must take over the role of a decider and solve situations in which players must pursue different conflicting goals by making a continuous series of decisions on a variety of actions and measures; (2) three of the features of the games are considered to structure players' practice of decision-making and foster processes of learning through the curation of possible decisions, the offering of lucid feedback and the modification of time. This article also highlights the games' shortcomings, from an educational perspective, as players' decisions are restricted by the numbers of choices they can make within the game, and certain choices are rewarded more than others. An educational application of the games must, therefore, entail a critical reflection of players' limited choices inside a necessarily biased system.

Keywords: decision-making; polytelic conflicts; problem-solving; digital games; game-based learning; gameplay loop; game design; geography education research; qualitative research

1. Introduction

Many societal challenges cannot be resolved with a simple solution. Making decisions to solve complex problems requires the consideration of several goals at the same time, which may be conflicted. Climate change is a prime example of such a problem in terms of how to reconcile the reduction of CO_2 emissions on the one hand against people's desire to carry on with their CO_2 intensive lifestyles (such as making plane trips, owning a car or consuming tropical fruits) on the other hand. Environmental measures may be in conflict with the capitalist economic model based on free trade, globalization, and aiming at continuous GDP growth. Ultimately, decision-making often includes multiple, conflicting perspectives. Solutions cannot solely be based on one measure, but require several complex measures. A great number of variables must be considered, and as part of such decision-making unintended side-effects should also be considered in such a "polytelic situation" [1] (p. 135). With this in mind, this article argues that games can be used as an educational tool to facilitate a better understanding of complex problems and teach reasonable decision-making, using geography education as an example.

The topic of "climate change" is a central subject in current geography education, in both middle and high schools. According to German national educational standards, instruction on the subject of climate change should aim to deliver subject-related content, but also to promote students' ability to make informed and justified evaluations and decisions, in line with the paradigm of education

for sustainable development [2]. The practice and facilitation of decision-making regarding climate change—as well as other topics, such as city planning, migration, and resource usage—requires sophisticated didactical approaches beyond top-down-instruction and class discussions. In this context, strategy and management games—which offer the promise of learning decision-making by doing—might be utilized as valuable teaching tools.

The use of games to teach decision-making—as part of complex problem-solving relevant for geography education—is supported by, at least, four main arguments. First, numerous studies have shown the potential of digital games—both serious and entertainment games—as a tool for education in general [3–5], and geography education in particular [6–9]. Second, a lot of strategy and management games refer to problems discussed in geography education and also arrange these problems in a spatial way. The games of the *Sim City* series and *Cities: Skylines* are, for instance, about city planning and the latter parts of *Civilization VI: Gathering Storm* about climate change. Third, decision-making is an inherent task in all (digital) games and even more so in strategy and management games. The designer of the *Civilization* series, Sid Meier, defined games as "a series of interesting choices" [10] (p. 200) and "a series of decisions" [11]. According to Salen and Zimmerman [12] (p. 316), the interaction between a player and a game must be understood as a circular relationship between the following steps, which other authors have called a gameplay loop [13]: "Player makes internal decision", "Player takes action", "Game creates output" [12] (p. 316), and then it starts all over again. In this sense, decision-making is a central element of all forms of gameplay and of the gameplay loop in general. Fourth, strategy and management games confront players with complex problems and "polytelic situations" [14] (p. 143) that require sophisticated forms of problem-solving, including informed and justified decision-making [1] (p. 135). In this genre, decision-making as part of the core gameplay can be considered as dynamic decision-making.

This article provides, among other things, evidence for the fourth point stated above. Furthermore, it explores the games' didactic principles to understand how strategy and management games support the practice of decision-making. Thereby, the article contributes to a body of literature that sheds light on the didactical possibilities of digital games, mentioned in the first point above [3–5]. The article builds on this field of research as a systematic examination of digital strategy and management games as tools for the practice of decision-making in and beyond geography education has not previously been carried out. While a couple of studies in the wider field of game studies (e.g., Reference [15]), examined the possibilities of decision-making in primarily narrative digital games with a focus on moral choices and proclaimed their educational potential, a systematic analysis investigating *game design features* that facilitate the *practice of decision-making* from an educational perspective is still missing. This study focuses on entertainment games rather than educational games, as it is assumed that the former excels when it comes to motivation in addition to learning mechanics, despite or precisely because their main aim is entertainment rather than education [3].

The paper answers the following research questions in relation to the games' and the game designer's overall design of dynamic decision-making:

- How do digital strategy and management games facilitate the practice of dynamic decision-making? (overall)
- To what extent do digital strategy and management games include polytelic conflicts that require dynamic decision-making? (see results Section 4.1)
- Which structural features/techniques of didactic mediation support the practice of dynamic decision-making? (see results Section 4.2)

Overall, the present study develops a theory of how digital strategy and management games may help to facilitate the practice of dynamic decision-making, based on a qualitative analysis of 17 games. In the following chapter, the paper summarizes relevant works from psychological research on decision-making—in particular, from the field of judgment and decision-making—and introduces a conceptual model which explains how strategy and management games facilitate the practice of

dynamic decision-making. Next, the methodology of the present study—a qualitative analysis of 17 selected entertainment games—is outlined. Afterwards, the article illustrates the model by presenting the results of the study, i.e., reconstructing the games' decision-making design from an educational perspective, in particular, in regard to the topics of city planning, climate change, migration and resource usage, which are highly relevant topics in geography education. In our analysis, we show how all of the games studied enable and moderate decision-making in general. We also outline how games differ in their particularities, both in terms of their polytelic conflicts and their techniques of didactic mediation. Finally, the conclusion summarizes the findings, including a discussion on the implications on the practice of geography education, and outlines work for future studies.

2. Theoretical Perspective and Conceptional Model

2.1. Decision-Making As a Concept in Psychology and Game Studies

Psychological research on decision-making refers to simple everyday problems, such as what clothes to put on in the morning, and highly complex, societal extremely relevant problems, such as how to deal with climate change.

By definition, a decision is based on a selection of at least two alternatives. Due to cognitive limitations, humans differ from algorithmic, rational decision-making by applying heuristics instead of comparing every possible option and all known variables. Kahneman [16] distinguishes between two modes of thought: System 1 thinking (fast) and System 2 thinking (slow). While System 1 allows humans to decide quickly using their intuition, System 2 applies a more sophisticated rational decision process. However, humans are still bound by cognitive biases and are influenced by framings. According to prospect theory, when humans decide between alternatives that involve risk, but know about the probabilities of the outcomes, they tend to be influenced by the frame of the story. In particular, people tend towards "risk aversion in choices involving sure gains and to risk seeking in choices involving sure losses" [17] (p. 263). Similar effects might occur when players are making decisions in games, particularly because the scope of possibilities in the games are necessarily shaped by other humans, namely, game designers.

Decision-making must be understood as a process—rather than only the end result of a decision. The concept of "decision-making" is situated between two other concepts: "Judgments" and "problem-solving". The process starts with a judgment of the respective decision situation which is the basis for the actual decision between at least two options which is then implemented and observed in the broader concept of problem-solving [18].

Dörner [19,20] studied sophisticated forms of judgment and decision-making in the 1980s in subjects relevant to today's geography education—such as in the area of city planning—based on computer simulations. His objective was "to study behavior of humans beings when they are confronted with the challenge of tackling problems in dynamic, uncertain and very complex systems" [21] (p. 1). Most of the scenarios Dörner studied in the 1980s resemble those of today's strategy and management games, and are relevant for geography education. In his well-known Lohhausen study—one of his computer simulations—his subjects were asked to adopt the role of a small town major over the period of 10 years and take care of the welfare of his or her inhabitants. In another study—Moro—subjects had to manage developmental aid in the Sahel region.

In his early work, Dörner [19,20] explained, among other things, how vulnerable human planning and decision-making is for errors and mistakes that stem from certain characteristics of the human mind. A major finding was that in planning and decision-making side and long-range effects are not adequately predicted and considered. Common errors and mistakes that have been found by Dörner and colleagues, while observing human behavior in complex, dynamic and uncertain domains of reality include mistakes of goal-elaboration, hypothesis-formation, prognosing, planning and control, which are all important aspects in decision-making. These tendencies are attributed to four main causes: "[T]he low capacity of human conscious thinking, which produces 'economic tendencies',

the strong motivation of humans to guard their feeling of competence, the overweight of the actual problems and forgetting" [21] (p. 18). In conclusion, the authors argue that computer simulations might help to prepare for decision making in complex, dynamic and uncertain realities.

Dörner/Funke [22] (p. 2) emphasized that the term "dynamic decision making" was first used by Edwards [23] in the 1960s "to describe decisions that come in a sequence" [22] (p. 2): "In dynamic situations, a new complication not found in the static situations arises. The environment in which the decision is set may be changing, either as a function of the sequence of decisions, or independently of them, or both. It is this possibility of an environment which changes, while you collect information about it which makes the task of dynamic decision theory so difficult and so much fun" [23] (p. 60).

Finding the solution to a complex problem requires "a series of operations" [1] (p. 135), including decision-making, and in the context of gaming, is referred to as gameplay (including a series of interesting decisions). Funke [1] (p. 135) defines this series of operations as follows:

- "Elements relevant to the solution process (of complex problems) are large (complexity), highly interconnected (connectivity), and dynamically changing over time (dynamics)."
- "Neither structure nor dynamics are disclosed (intransparency)."
- "Finally, the goal structure is not as straight forward as suggested above: In dealing with a complex problem, a person is confronted with a number of different goal facets to be weighted and coordinated—a polytelic situation."

The concept of "polytelic situation"—polytely is the Greek term for "many goals"—is central in the context of this research. The inherent polytelic conflict of complex problems implies that the decision-maker is confronted with conflicting goals that need to be conciliated. Betsch et al. [14] (p. 143) show that the core gameplay of strategy games, such as *Age of Empires*, is based around polytelic conflicts, i.e., that strategy games are usually built around a complicated system of interdependencies and conflicting goals that require the player to identify their priorities and make a series of decisions [14] (p. 143). In game studies, goals are usually seen as "the objectives or conditions that define success in the game" [24] (p. 5). From a game design point of view, a game's demand for a series of interesting decisions as part of the gameplay loop is actually the reason for the games' appeal [10–12].

In dynamic decision-making, based on a series of decisions, isolated decisions might vary in their levels of abstraction. On the one hand, there are more general overall decisions—such as to reduce the production of CO_2—which then must be split further through sub-decisions—such as to make public transport affordable and efficient, support affordable high-density living in the city or similar.

In contrast to the above-cited psychological works, our study did not focus on players' decisions, but rather on the structure of the polytelic situations presented in the selected games and the decision-making they allow and require, also described as the possibilities of decision-making, including constraints that limit and influence players' decision-making. Consequently, this study reconstructs the decision-making design of the selected entertainment games and assesses whether such games may be an adequate learning tool to prepare students for decision-making in the subject of geography. A follow-up study will investigate the decisions of players when playing the games in a pedagogical context.

2.2. Model of Decision-Making Design in Digital Games

This research looks at decision-making design in entertainment games that are simulating complex problems in a playful manner, which is expected to motivate [3] (pp. 58–62), as well as promote learning [3] (pp. 71–111). In contrast to pure simulations, such games do not intend to create a fully realistic model of the chosen systems and may, therefore, be somewhat simplified. Instead, games, by definition, aim to offer an entertaining play experience. Thereby, they promise to increase students' intrinsic motivation [25], but may offer inadequate models of reality. Strategy and management games stand between the genres of "simulations"—which should be "true" in the first instance—and "games"—which are intended to be "fun" [26] (p. 503). If we suppose from an educational perspective

that games should convey meaning, as well as foster motivation to learn, there must be a balance between simulation and game, and between trueness of the simulation and enjoyment of the player.

We subsequently introduce our model of decision-making design and practice in strategy and management games, which is based on three main concepts: (1) The game's inherent polytelic conflict; (2) the game's didactic mediation and; (3) the initiated gameplay loop (see Figure 1). While (1) the polytelic conflict and (2) didactic mediation solely refers to the game as such, i.e., to the decision-making design, (3)—the initiated gameplay loop—models the circular interaction between game and player, including a player's practice of decision-making.

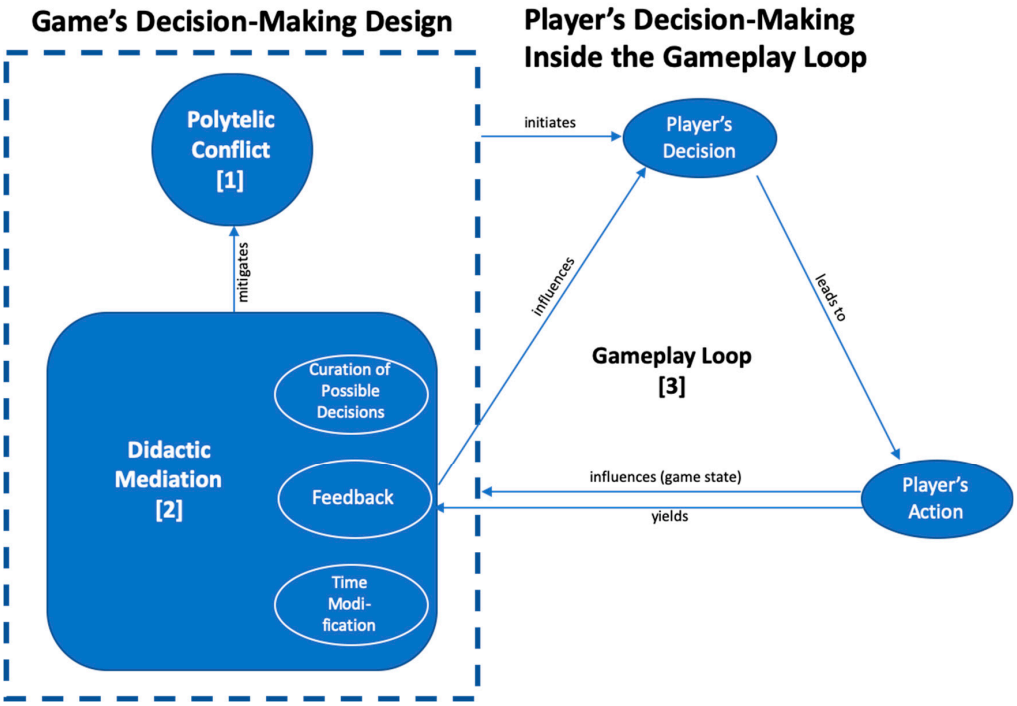

Figure 1. Model of decision-making design in digital games (own illustration, including an adapted depiction of the gameplay loop from Salen/Zimmerman [12], p. 316).

We assume that strategy and management games offer the possibility to practice dynamic decision-making by confronting players with complex problems including polytelic conflicts (1) [1,19,20] which create a scope of possibilities and require a continuous series of decisions from the players. The complex problems/polytelic conflicts motivate players to engage in problem-solving and decision-making. Thereby, the complex problems/polytelic conflicts initiate the gameplay loop (3), which contains a circular sequence of players' decisions, players' actions, and feedback of the game [12] (p. 316). Players' practice/learning of dynamic decision-making, which consists, by definition, of "decisions that come in a sequence" [22] (p. 2), can be situated inside this very loop. Therefore, the concept of the gameplay loop plays a pivotal role when it comes to the explanation of how digital strategy and management games are able to facilitate the practice of dynamic decision-making. In all, the gameplay loop contributes to both the enjoyment and the learning of the player [27,28].

Furthermore, we presume that the above-mentioned in-game problems diverge considerably from the real-world problems they model. These games modify and mitigate the problems they depict significantly because games (unlike simulations) should be enjoyable (not real). Among other things, digital games intent to motivate their players by allowing them to master the challenges of the game (for an overview of game definitions see Reference [26]). Consequently, games imply a didactic mediation of the problem/conflict (2 in Figure 1), which is understood in the context of this research as a series of techniques that reduce the complexity of a game to let its players cope with the

challenges of the game and potentially help them to practice dynamic decision-making. Our analysis identifies the following means/techniques of game design: Curation of possible decisions (i.e., selection, organization, presentation, and implicit rating of possible measures); audiovisual feedback to player's decisions and actions and; modification of time (through designers' pacing and players' options to determine the passage of time) (see Figure 1). All in all, these techniques reduce the challenge of the complex problem—including the polytelic conflict—and make the decision-making processes more transparent. However, as players tend to get bored if the challenge of the game is too low for their current skill level, the didactic mediation should not go too far. Instead, the game must ensure that the difficulty level of the game hits the sweet spot between the challenges of the game and the skills of the player. An important consideration is that skill levels develop over time and differ from player to player. Thus, the game needs to apply forms of adaptation for developing skill levels of individuals, as well as for differences between players.

Although our model and analysis focus on the games' decision-making design, expected player behavior is also modelled. Implications and consequences for the player are derived throughout these analyses. In this context, the concept of the gameplay loop helps to bridge the design of the game on the one hand, and the decision-making and actions of the player on the other hand (see above). Unlike other design models, our model includes both the game design—more precisely, the decision-making design—and the behavior of the players—specifically their decision-making. The concept of the gameplay loop allows the modelling of the interactive/circular relationship between both aspects.

In the first part of our analysis (Section 4.1), we examine to what extent the decision-making spaces of the games correspond to polytelic conflicts (1 in Figure 1)—i.e., situations in which players must pursue different conflicting goals that require dynamic decision-making. In the second part of our analysis (Section 4.2), we uncover the above-mentioned techniques of didactic mediation (2 in Figure 1) that help to explain how games support the practice of dynamic decision-making.

3. Materials and Methods

The study examined 17 strategy and management games. These games were selected according to the following criteria: (1) Include at least one of the following geographical topics of pivotal importance for current geography education—such as city planning, climate change, migration or resource usage; (2) are popular and/or well-received by critics, as those games promise to be in particular motivating to students and have a great influence on the knowledge and attitudes of students on the above mentioned topics and; (3) are suitable for students aged between 10 and 18 years, as in German schools geography is taught from school years 5 to 13. For the second criteria, we analyzed sales according to the website Steam Spy and/or Google Play; user scores according to data from Apple, Google Play, Steam and Metacritics; and the reception by game critics according to the website Metacritics that aggregates reviews. For the third criteria, we considered the games' age rating according to PEGI (Pan European Game Information), which is a European video game content rating system.

During the selection process for the overall research project on the possibilities of digital games for geography education, we collected data from 109 digital games of diverse genres that may fulfill the above-mentioned criteria. For the present study, we excluded those games that meet the criteria, but belong to other genres, as the study focuses on decision-making relevant for the realms of public policy and business administration which is prevalent only in strategy and management games. The final selection for the present study was not only based on a quantitative analysis of the collected data, but also a qualitative judgment by the authors. We excluded, for instance, those games that treat the geographical topics solely as a setting for gameplay without having any curricular relevance. The games in our final selection have sold at least 50,000 copies (while a lot of them have sold multiple times more) and received a positive average rating from players and/or critics on at least one of the examined platforms. The selected games (in alphabetical order) are: Age of Empires 2, Anno 1800, Anno 2070, Banished, Cities in Motion 2, Cities: Skylines (including the DLCs Green Cities and Natural Disasters), Civilization VI: Gathering Storm, Democracy 3, Fate of the World: Tipping Point (including

the DLCs Migration and Denial), Frostpunk, Pocket City, Rise of Industry, Settlers 7 (History Edition), Sim City Build It, SimCity 4 Deluxe Edition, Transport Fever, Tropico 6.

Our qualitative analysis comparatively examined the selected games based on predefined categories (see Table 1). The categories for the analysis were derived from the literature in game studies and psychology, as well as our own theoretical model (see Figure 1). Each game was played by two informants (student assistants), as well as the article's authors. A cross-classified analysis table was filled out collaboratively. Further categories were derived from the material in the course of the analysis process. Thus, the analysis includes a combination of deductive and inductive category development. Figure 2 depicts our research design.

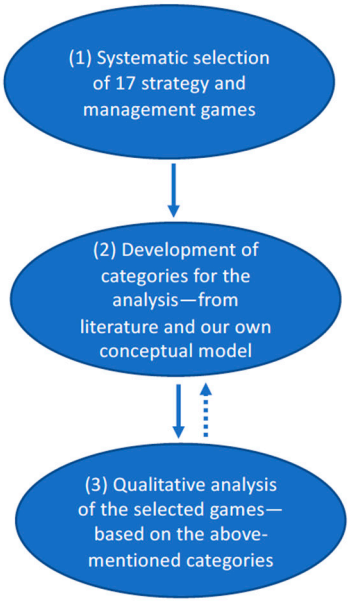

Figure 2. Research design.

Table 1 presents an overview of the overall concepts and categories (in order of appearance in the sections of the results chapter), the respective focus and procedure of analysis (in these sections), and examples for the aforementioned analyses:

Table 1. Overview of concepts and categories.

Overall Concepts and Categories	Focus and Procedure of Analysis	Examples
Polytelic Conflicts (Section 4.1)	The section analyzes whether there are polytelic conflicts [1] (p. 135) in the games and how they arise. In this context, the (conflicting) goals that the player must pursue in the game are considered.	In *Fate of the World* players must combat climate change (Goal 1) and still deliver decent figures of human development index and GDP (Goal 2). The above-mentioned goals are partly in conflict with each other, and thus, create a polytelic conflict.
	A distinction is made between open/ill-defined goals and well-defined goals [21] (p. 2).	Taking care of the welfare of the player's inhabitants in *Cities Skyline* is an ill-defined goal, while earning as much money as possible in *Rise of Industry* is a well-defined goal.
	Polytelic conflicts often imply a certain degree of intransparency [21] (p. 2), which requires players to "develop hypotheses about the inner structure of the system" [21] (p. 2).	

Table 1. *Cont.*

Overall Concepts and Categories	Focus and Procedure of Analysis	Examples
Techniques of didactic mediation (Section 4.2)	The section investigates three overall techniques of didactic mediation understood as means to reduce complexity to let players cope with the challenges of the games and help them to practice dynamic decision-making: Curation of the scope of possibilities (Section 4.2.1), Feedback to players' decisions and actions (Section 4.2.2), Time modification (Section 4.2.3).	
Curation of the scope of possibilities (Section 4.2.1)	Based on an analysis of the spectrum of measures offered by the game that the player can decide upon to influence the parameters of the game, the subsection examines the games' curation of the scope of possibilities with particular consideration of the winning/success conditions which shape players' decision-making significantly.	In *Democracy 3*, measures equal government policies, including the passing of laws, budgeting and investing. The game's predefined policies are ordered into seven fields: Tax, economy, public services, welfare, transport, law and order, and foreign policy. Success conditions in *Democracy 3*: Keeping the majority of voters on the side of the player's government (to win elections) and ensure that none of the interest groups in the game gets to such an extent dissatisfied that they form a terrorist organization (to avoid assassination)—for as many terms of office as possible.
Feedback to players' decisions and actions (Section 4.2.2)	This subsection focuses on the causality of decisions and feedback mechanisms, i.e., it reconstructs the relationship between actions/decisions and their effects, as well as the ways the games communicate those effects to the players, i.e., how the games offer feedback to players' decisions and actions.	In *Democracy 3*, one form of feedback is communicated to the player after each round in the respective quarterly report in the form of statistics on GDP, health, education, unemployment, crime and poverty (more statistics can be accessed any time proactively by the player).
Time modification (Section 4.2.3)	The subsection reconstructs how the games handle time, as well as how the games allow their players to determine time themselves—and thereby increase the attractiveness of in-game decision-making, as well as facilitate its practice. The analysis is based on two categories: Relation of play time and event time: The connection between real play time and the time that has passed in the game [29]. Action mode—real-time vs. turn-based: While in real-time games there is a "ticking clock" (i.e., players' actions are time critical), in turn-based games the players decide themselves how long they take for a single round.	In *SimCity* playing for two minutes makes a year pass in the event time/game world [29]. *Civilization* is turn-based without being time critical: The players end their round when they are ready. *Age of Empires II* is a real-time strategy game: Gameplay is continuous.

The analysis focused on the games, in particular their design of decision-making. However, we also derived consequences for the player, who is an integral part of our model. These implications for the players' practice of dynamic decision-making are discussed throughout the paper.

4. Comparative Analysis of Digital Games

4.1. Polytelic Conflicts

The analysis in this section determines to what extent the goals and challenges of the games include polytelic conflicts—i.e., situations in which players must pursue different conflicting goals—and thereby foster dynamic decision-making. These analyses outline the common nature of all games' polytelic conflicts (i.e., their commonalities in structure), but also illuminate the differences between games, in particular with regards to the character of the challenges—i.e., their differences in structure.

In general, the overall goals of the analyzed strategy and management games are similar: Players must accomplish economic efficiency and/or economic growth (in 17 of 17 games), as well as (further) development of a nation, a city, a settlement, a transport infrastructure, or a similar entity, i.e., spatial and/or population growth and/or the adoption of increasingly "modern" technology (in 17 of 17 games). In many games—more precisely, in 14 of 17—players must also ensure the well-being of and/or the

approval by the population. In 10 of 17 games, it is necessary to control pollution and/or climate change and pursue some kind of sustainability goal—for example, players must keep the ecobalance high in *Anno 2070*. Some games have additional goals, such as superiority over other parties, for example, military (e.g., *Age of Empires 2* and *Civilization VI*) or cultural (*Civilization VI*) superiority. Table 2 presents an overview of the occurrence of the four most common and relevant goals in all analyzed games.

Table 2. Overview of the occurrence of the four most common and relevant goals in all analyzed games.

	Economic Efficiency and/or Economic Growth	Development of a Nation, a City, a Settlement, a Transport Infrastructure, or a Similar Entity	Well-Being of and/or Approval by the Population	Control of Pollution and/or Climate Change
Age of Empires 2	x	x		
Anno 1800	x	x	x	x
Anno 2070	x	x	x	x
Banished	x	x	x	
Cities in Motion 2	x	x	x	
Cities: Skylines	x	x	x	x
Civilization VI	x	x	x	x
Democracy 3	x	x	x	x
Fate of the World	x	x	x	x
Frostpunk	x	x	x	
Pocket City	x	x	x	x
Rise of Industry	x	x	x	
Settlers 7	x	x		
Sim City Build It	x	x	x	x
SimCity 4	x	x	x	x
Transport Fever	x	x		
Tropico 6	x	x	x	x
Percentage (of games)	100%	100%	82.35%	58.82%

However, overall goals differ—in their grade of abstraction (the complexity of their relationship to various interacting parameters of the game) and weight (their importance for being successful in the game). For instance, in *Democracy 3*, economic growth is more complex and more important for success than in *Pocket City*. In most of the games, the control of pollution and/or climate change is less important than the other above-mentioned goals, while it is a priority goal in *Anno* 2070, *Civilization VI: Gathering Storm* and *Fate of the World*.

Partially, the above-mentioned overall goals—such as economic growth, the happiness of the population, and ecobalance—are in distinct and fundamental conflict with each other. In *Fate of the World*, for instance, players must prevent climate change as far as possible, yet still deliver a high GDP. However, in most cases conflicts are less dichotomic and more ambiguous, appearing on a lower level, while players micro-manage the game world. For example, if players in *Cities: Skylines* want to improve their flow of traffic in an already established city, in order to ensure economic growth by expanding their network of streets, they may have to tear down houses, which leads to temporary negative population growth. Other negative implications may be heavier pollution, and the unhappiness of residents. In this case, the goal of economic growth must be balanced with other goals, such as the happiness of citizens, but these kinds of conflicts are not simple and fundamental, because economic growth, for instance, may have both a positive and a negative effect on happiness as it leads to such issues as less unemployment and higher wages, but also to more pollution.

Other conflicts relate to the allocation of limited budgets. Players must decide for which exact purposes they want to use their budgets. In all city builder games, for example, players can opt to

invest in amenities, such as amusement parks, but they can also decide to spend their money on developing new factories. In *SimCity BuildIt* players must decide between expensive and "clean" wind energy and low-priced, but "dirty" coal at the start of the game. According to the logic of this game, pollution must be limited to keep players' citizens happy, while players also have to boost the economy and monitor their budgets.

In addition, in some games players have to weight and settle the conflicting interests of a variety of constructed subgroups, such as inhabitants of a common space (e.g., a district in *Cities: Skylines*), supporters of a political attitude, or carriers of a demographic characteristic. *Tropico 6* includes different political factions: Revolutionaries, communists, capitalists, religious, militarists; later on also environmentalists, industrialists, conservatives, intellectuals. In *Democracy 3*, the voters are subdivided into 21 groups: Socialists, capitalists, retired, commuters, patriots, motorists, liberals, religious, trade unionists, freelancers, environmentalists, rich, poor, middle-income, parents, farmers, public servants, conservatives, youth and ethnic minorities.

In terms of geography education, it is particularly interesting that the polytelic conflicts modelled in the games usually play out in a visual representation of space on a 3D-map (one of the exceptions being *Democracy 3*), and thus, centrally represent space—one of the core concepts of geography. Many polytelic situations include a direct spatial component—i.e., conflicts about the usage of space, such as traffic vs. recreation, which is common in all of the analyzed city builders. In other words, most games are about spatial conflicts which require spatial thinking and decision-making.

Typically, for polytelic conflicts, the way of achieving a certain goal is not necessarily straightforward. Measures taken do not always (only) lead to the intended effects, and unintended side-effects may appear. The construction of a factory in city builders, such as *Cities: Skylines* or *SimCity BuildIt* might lead to jobs in the area, but also to pollution and unhappiness of direct neighbors. Weak labor laws and low wages, in *Democracy 3*, may save or increase the number of jobs, but cause unhappiness of workers, low productivity and low spending power. Usually, the games imply both well-defined goals—such as earning revenues—and ill-defined goals—such as improving the welfare of gameworld inhabitants. The latter implies an extra challenge because they require players to implicitly define these concepts themselves. In the course of these games, players must "develop hypotheses about the inner structure of the system" [21] (p. 2) to overcome its intransparency.

It is up to the players to reconcile the competing/conflicting goals, and consequently, to solve the polytelic conflicts of the game. In this context, they have to set priorities and at least implicitly decide upon an overall strategy, which is then implemented over the course of the game by a continuous series of decisions—i.e., players must continuously choose the best possible next step as part of a wider series of actions, and adjust the overall strategy using the feedback of the game.

According to evidence from player research, for most avid players of the genre, polytelic conflicts are a central reason for their motivation to play these kinds of games. They enjoy the challenge of balancing the various conflicting goals, as well as the difficulty of complex decision-making. Players are also fond of thinking, planning, making long-term strategies and considering consequences when they play digital strategy and management games [30] (p. 7).

As all strategy and management games—and particularly those with well-defined goals—set more or less specific overall goals that are linked to the main parameters (such as budget and happiness) and the success conditions, players are strongly encouraged to pursue those goals instead of deciding to follow their own goals (see the discussion of the role of winning conditions in Section 4.2.1). However, players autonomy should not be underestimated. In principle, players can contradict the goals of the games and pursue their own goals, if winning is not a key aspect of their personal gaming motivation in a particular session. This is especially true for those games with an open world and non-linear story structure. In *Cities: Skylines*, for instance, players can dedicate themselves solely to build a beautiful or recreate an existing city instead of building an economically successful city. In *Democracy 3*, players can tinker with political philosophies and try to set up a utopian state of their own choice beyond the supposedly rational decision-making of "Realpolitik" [31].

4.2. Techniques of Didactic Mediation

We assume that certain structural features of strategy and management games mitigate the above-described challenges and foster processes of learning. The sum of these features can be, thus, referred to as didactical design, the process initiated by the features as didactic mediation and the particular features as techniques of didactic mediation.

In our analysis, we found that players' practice of decision-making is supported by three techniques of didactic mediation: (1) The curation of the scope of possibilities, i.e., the selection, organization, presentation, and (implicit) rating of possible measures and decisions; (2) the offering of lucid accelerated feedback to players' decisions and actions (as part of the gameplay loop); and (3) the modification of time.

Subsequently, we outline the above-mentioned features/techniques in greater detail and consider how strategy and management games mitigate the challenges of complex problems and polytelic conflicts and allow the practice and reflection of dynamic decision-making. These processes are found to reduce complexity, decrease intransparency, soften indefiniteness, reveal interconnectedness, decrease the time between measures and effects and help players to cope with the dynamics of decision-making.

4.2.1. Curation of the Scope of Possibilities (Possible Decisions)

Based on an analysis of the measures offered by the games that players can decide upon to influence the parameters of the games, this subsection illustrates how the games curate players' scope of possibilities. We understand the concept of *curation* by the game in this context as selection (including limitation), organization, presentation, and (implicit) rating of possible decisions. All in all, the subsection unveils a genre-specific dichotomy between players' freedom of choice and behaviors afforded by the games.

All examined strategy and management games are based on complex problems and polytelic situations, which, in turn, allows their players a relatively wide spectrum of measures and decisions. In contrast to narrative games, which are usually based on a highly limited amount of predefined routes and endings, in strategy and management games, the players' freedom for decision-making is wider and allows for nuances. Players do not only decide about fixed alternative routes (branches), but instead create their own way through the games by a series of smaller decisions, in other words, by the manipulation of a variety of system variables. In games, such as *Tropico 6* or *Democracy 3*, for instance, players can set up their own self-constructed political regimes respectively systems of regulations and policies instead of choosing only between fixed options, such as socialism and capitalism, for example. In doing so, players may opt for extreme political actions, but they could alternatively opt for more nuanced forms of policies. The wide spectrum of measures allows players to explore a variety of possibilities, which may be suitable for an educational application.

After players have taken an overall decision on a certain matter and thereby set up a personal goal (first level decisions), they will implement/operationalize this major decision through a series of continuous smaller decisions (second level decisions) followed by actions, which can be conceptionally situated inside the gameplay loop component of our decision-making design model. These kinds of decisions refer to the realization of concrete measures based on the manipulation of variables represented in the games. Typically, strategy and management games offer players a toolbox of measures to implement their decisions, including the act of zoning, placement of buildings and infrastructure, investments in different policy fields, passing of laws, production of goods and trading.

If players of *Cities: Skylines* (including the *Green Cities* DLC), for instance, decide to consistently go green and increase their cities' sustainability, they can use a wide spectrum of measures, such as the construction of environmentally-friendly buildings, the production of electric cars, the facilitation of urban gardening, and switch to new ways of winning electricity (e.g., solar updraft tower, thermal energy), garbage collection (e.g., floating garbage collector, recycling center), and water supply (e.g., eco water treatment center). Additionally, it is also possible to implement a toll on fossil fuel vehicles whilst hybrid and electric vehicles entering a certain district do not have to pay the toll (i.e., congestion pricing).

However, while pursuing personal goals for overall decisions, such as the above-mentioned measures (in the example: Going green), players must also take other, possibly conflicting goals into account, i.e., the polytelic conflicts of the game (as described in the last section)—in case they are interested in being successful in the game. When it comes to the topic of climate change, for example, there might be a conflict between the reduction of CO_2 emissions and employment in the automotive industry (because one measure to reach the reduction would be the replacement of individual transport by public transport). In addition, players have to consider unintended side-effects. In *Fate of the World*, for instance, the extension of e-mobility (a measure to go green) raises the energy demand, which can lead to a higher consumption of coal, which raises CO_2-emission [32].

Although the analyzed strategy and management games imply a wide spectrum of measures in contrast to more linear narrative games and allow players the freedom to make their own decisions (as described above), the games' limit the number of possible decisions. Despite the games offering players a significantly higher amount of influence than any political or business leader would possess in democratic structures, their powers are certainly constrained, rendering their sense of almightiness to be at least partly an illusion. As computational representations of reality, these games are necessarily based on a selection of measures, and thus, offer only a limited scope of possibilities. The players still pick from predefined sets of measures, instead of having complete freedom of choice. Certain options are simply not possible, which suits the purpose of didactic mediation. In general, this reduction of complexity through the selection and limitation of measures and possible decisions is a necessary means in entertainment games and educational technology, which is required to ensure motivation and foster learning processes. However, from an educational perspective, this approach also has to be discussed critically, as every selection/limitation implies the risk of being biased. As Bereitschaft [8] (p. 51) noted in his analysis of city building games, "players are constrained by the developers' assumptions and biases regarding how cities ought to look and function". According to Bereitschaft city building games, for instance, "emphasize personal transportation over transit" [8] (p. 51) and the development of a large number of measures needed to create a sustainable city in *Cities: Skylines* cannot be implemented without the *Green Cities* DLC.

The absence of democratic negotiation processes oversimplifies decision-making further, and despite its important function when it comes to games' play- and enjoyability, from an educational perspective, it is problematic.

Another way of simplifying and supporting players' decision-making is the organization of measures according to categories. The structure of categorization (as well as the available measures and variables that can be manipulated) differs from game to game. *Democracy 3*, for example, distinguishes between seven policy fields: Tax, economy, public services, welfare, transport, law and order and foreign policy. These policy fields are represented in seven distinct areas in the user interface; taking up the largest part of the screen and grouping the available measures (Figure 3—the Economy highlighted).

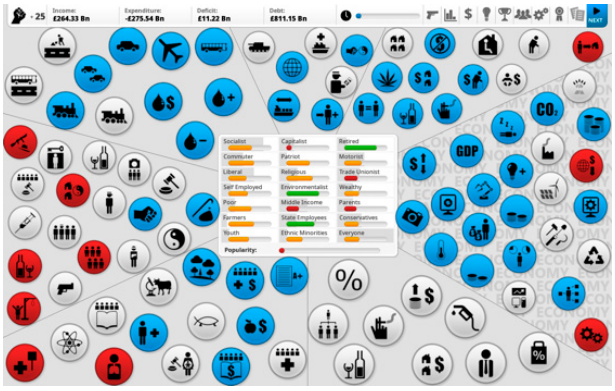

Figure 3. User Interface of Democracy 3 depicting seven policy fields (Screenshot).

In addition to the aforementioned limitation of available measures, players' decisions are also influenced by the games' (implicit) rating of measures in terms of their effectiveness for being successful in the games. The games' winning/success conditions (and losing conditions) have a significant impact on players' choices. Assuming that players play to win the game—at least if they understand their current game in the logics of Caillois [33] as a competitive game of agôn—they will make decisions based on whatever it takes to be successful in the game. Only in cases where players have intentions different to that (or on top) of winning the game—e.g., experimenting with the game (understanding their current game according to Caillois as mimicry or roleplaying)—the winning/success (and losing conditions) are less important for decision-making. In short: The game's winning/success conditions significantly shape the scope of decision-making.

Democracy 3, for instance, affords the measure of the death penalty because it leads to success in the game in the form of a decrease in the crime rate. In *Civilization VI: Gathering Storm*, the investment in technological measures is a more effective means to tackle climate change than the induction of behavioral changes by political actions, such as taxation of fossil fuels. The most effective (though unrealistic) curative measure to combat climate changes in the game is the so called "carbon recapture project" which builds an industrial zone district (or a replacement) and discovers a method for global warming mitigation. Each completion of the project awards the player 30 diplomatic favor and reduces the civilization's lifetime carbon emissions by 50 CO_2 points. It allows players to win the climate accords—a scored competition in the game—although the player is still the biggest polluter of the world. Thereby, the game highly influences and restricts players' decision-making who will most likely opt for these, in reality, currently unrealistic technocratic measures. From the perspective of formal education, it must be problematized that the game is built on the assumption that climate change can be solely cured by technology, through a tech fix invented by human minds, a form of geoengineering. It believes that humans in the Anthropocene can control nature and finally succeed over it. According to the majority of experts on climate change from various disciplines, however, humans cannot solely rely on technological measures/solutions. Instead, changes on the social, political, economic, and cultural sides are absolutely necessary [34] (p. 22).

While some games have a well-defined winning condition, other games cannot be won in the classical sense, such as winning a game of chess (a game with opponents) where one player's victory is another player's defeat and the end of the game.

A good example of a game with a clear winning condition is *Civilization VI*. Players can win this game in a number of different ways: Scientific victory (a player achieves the ultimate scientific event "Exoplanet expedition launch"), domination victory (a player conquers the capital of every other civilization in the game), religious victory (a player's religion reaches 50% of the cities of all the different civilizations), cultural victory (a player attracts more visiting tourists in his or her country than all other civilizations do), diplomatic victory (a player wins 10 diplomatic points, earned by having political propositions at the world congress adopted, or creating certain wonders or achievements), point victory (a player has the highest score of winning points in an individually set year).

Civilization's winning conditions imply clear ideas of a "good" city/nation development, which is very much based on the colonial logic of domination. The game, therefore, strongly pushes players' decision-making in a certain direction, restricting them from thinking about their normative goals. *Civilization* furthermore implies a clear idea of the development of history. If players want to be successful in the game, they have to develop their civilization through predefined biased stages of history—from agricultural to industrial to service society and from feudal to democratic forms of government—which relieves the players from a lot of major decisions when it comes to the goals they pursue (first level decisions). In addition, the game also guides players when it comes to decisions on a lower level through guiding decisions about the actual way of reaching a particular goal (second level decisions). The code of the game implies a clear statement about "right" and "wrong" decisions; while "right" decisions award the players and lead them to progress in the game—i.e., to our current society, as a necessary goal of the game/history—others are "wrong" and slow down the progress of

predefined historical developments. In general, in the context of a possible application of the examined strategy and management games in the (geography) classroom, the games' assumptions about what constitutes "good" city planning, "good" immigration policies, "good" reactions to climate change and "good" resource management must be critically considered.

Another game with clearly defined winning (and losing) conditions is *Fate of the World*. The conditions in this game depend on the scenario and relate to certain variables, such as the amount of allowed warming in degrees or human development index. Players must reach all objectives—i.e., winning conditions—without reaching one of the losing conditions. The scenario "Three Degrees", for example, announces the following winning and losing conditions to the player: "Win Conditions: Reach the year 2200 with global warming below three degrees. Lose Conditions: The global HDI falls below 0.5; GEO is banned from seven or more regions at once; global warming is above three degrees by 2200; you lose control of a GEO HQ region." Thus, the directions of players' actions are predetermined by the game. It is not the player who makes the overall decision of following particular goals, but the game. The player only implements the overall decision (first level decision), by deciding about the way of achieving the overall decision/goal (second level decision). Thereby, the game strongly shapes the decision-making of the player.

Furthermore, it can be predicted that games with clear winning conditions also influence their players insofar as under competitive conditions players will be more likely to play to win instead of other purposes—a claim that can be backed up with research from psychology which investigates the impact of exposure to competitive environments on behavior, motivation and performance [35].

In contrast to the above-mentioned games, city builders, such as *Cities: Skylines*, usually do not come with clear winning conditions. *Cities: Skylines* is open end, and a final victory cannot be achieved. Instead, it is up to the players what they define as success, though players can actually lose the game—e.g., by going financially bankrupt or the destruction of their city through natural disasters. Whereas some players might find pleasure in building cities to be aesthetically pleasing, others aim for ongoing growth of size and inhabitants. However, *Cities: Skylines* supports a certain way of gameplay and sets success conditions by rewarding the progress of the city, which is defined by the number of inhabitants and rewarded with unlocking of buildings and further possibilities. In this sense, this game follows a capitalist logic of growth and expansion. Nevertheless, the less clear winning conditions compared to strategy games, such as *Civilization*, for instance, allow players bigger freedom of decision-making.

In conclusion, some games (e.g., *Civilization VI* or *Fate of the World*) have clearly defined conditions for winning and losing, while others (e.g., the city builders) have somewhat vague success conditions that are up for interpretation by players. Games with clear winning conditions guide players' decision-making stronger than games with less clear winning conditions. Overall, in contrast to more linear digital games, the relatively open worlds of strategy and management games offer their players a wide scope of possibilities. This openness enables players to come up with their own decisions and solution to the polytelic conflicts of the games. Together with other structural features of the games, such as their ways of offering feedback and modification of time (that are discussed in the remaining parts of this section), it facilitates players tinkering with different self-created solutions, trying out a variety of decisions, and learning about their effects on the system. Thus, the games permit players to realize that there are different ways of solving a problem and analyze their previous decision-making.

On the other hand, the games influence players' decision-making. The curation of the scope of possibilities, in particular the limitation and organization of measures, makes decision-making easier and thereby allows players to be successful and develop an understanding of dynamic decision-making. However, the curation by the games also manipulates/frames players' decision-making by restricting the numbers of choices and rewarding certain choices more than others (in accordance with the logic of "games as competition"), which must be critically considered from an educational point of view. Thus, an application of the games in classroom settings requires that teachers let students reflect on these kinds of framing processes.

4.2.2. Feedback to Players' Decisions and Actions

This subsection focuses on the causality of decisions and feedback mechanisms, reconstructing the relationship between players' actions/decisions and their effects on the game state, which corresponds to players' relative successfulness according to the games' winning/losing conditions, as well as the ways in which the games communicate those effects to the players—i.e., when and how the games offer feedback to their players.

According to evidence from psychology [14] (pp. 112–114.), decision-making is learned through feedback and the law of effect [36]. Thus, humans learn for future decision-making from the results of previous-decision making. As game designers are able to control feedback (e.g., can offer it earlier as it is the case in real life contexts), well-designed games promise to be excellent tools to support the practice of decision-making. This learning process can be conceptually located within the gameplay loop component of our model of decision-making design (see Figure 1), representing the circular relationship between players' decisions and actions and the feedback of the game.

Before we focus on the feedback mechanisms as such, it makes sense to have a general look at the relationship between players' decisions/actions and effects. Dynamic decision-making, as part of complex problem-solving, must consider interdependencies between parameters consisting of not only simple and direct effects, but also complex chains of influence (including indirect effects). Due to the intransparency of these chains of influence, as well as the polytelic nature of the problems, people solving complex problems will also be confronted with unintended side-effects. When it comes to the effects of players' decisions, and the "causality of decisions" the games in our sample differ. The main difference between games lies in the complexity of the cause-and-effect relationship.

Games, such as *Banished* or *Pocket City*—whose gameplay builds on rather direct relationships between players' decisions/actions and effects—include relatively immediate feedback (see below). In these games, the outcomes of a decision are clear from the beginning, with a certain measure leading to a more or less foreseeable effect on one or more parameters. For example, if players decide to decrease congestion in *Pocket City* citizen happiness and city desirability increases. Side-effects do occur, but are still relatively predictable. If players raise taxes in *Pocket City*, they have a bigger budget and more space for investment decisions, but less happy citizens, which reduces (in the unrealistic logic of this game) population growth.

In contrast, games, such as *Civilization VI: Gathering Storm*, *Democracy 3* and *Fate of the World*, are built around more complex problems. *Fate of the World* entails a particular complex chain of influence as all parameters are interdependent. For example, the parameter "industry" is connected to the energy, water, transport, oil, gas, coal, water use, toxicity, GDP, and emissions parameters. Each decision that is focused on one parameter has an influence on almost all other parameters, often with unintended follow-up effects. Due to the higher complexity of these games, the outcomes of a decision are less easy to foresee, including the higher occurrence of unintended side-effects. The interdependencies between measures and key parameters for decision-making and their abstractions are more complex, and the feedback to players' decisions is often less immediate.

Most games studied in our sample allow players to monitor their performances relating to the main parameters of the game at all times in the main interface through data on budget, the number of inhabitants and happiness of inhabitants, which are either updated in real-time or after each round, depending on the action mode (see Section 4.2.3). In deeper levels of the interface, more comprehensive data can be accessed proactively by players. However, in many cases, the games deliver feedback proactively through the use of pop-ups and messages to the player.

There are three forms of feedback delivery most relevant to dynamic decision-making: (1) Numerical data and graphs; (2) texts (partly embedded in the narration of the games, via storytelling by the narrator or messages from non-player characters, such as citizens or opposition parties) and; (3) modelled consequences, usually animated in maps, or geographic information systems (GIS). In the context of the genre of strategy and management games, which are often played without sound (e.g.,

when played mobile or as part of multitasking), visual feedback is more important than sonar feedback, and if sonar feedback plays a role, it usually plays a supporting role for visual feedback.

In comparison to reality, all our analyzed games offer accelerated feedback. Thereby, the games decrease the time between measures and effects, which is usually one of the challenges of complex problems (see Section 4.2.3 for a detailed discussion of the role of time modification/pacing as a game design feature). The games examined in our comparative analysis differed in the velocity of their feedback delivery. While some—such as the mobile game *Pocket City*—offer comprehensive immediate feedback after single inputs by the players in the form of visual text boxes, for instance, in other games players have to wait longer to receive feedback. In *Democracy 3*, for example, one form of feedback is communicated to the player after each round (instead of after each action) in the respective quarterly report, which is presented in the form of statistics on GDP, health, education, unemployment, crime and poverty (more statistics can be accessed any time proactively by the player). Another form of feedback is given at any time in the middle of the main menu, which is also updated after each round, and includes the happiness of the 20 voter groups with regards to the policies of the respective player represented using colored bar charts. In *Civilization VI: Gathering Storm*, it takes a large number of turns for players to get feedback on the outcome of a particular decision, including information as to whether the actions of a particular turn have been successful. In fact, the relatively long time to receive feedback combined with a relatively high level of uncertainty, and thus, difficulty (in contrast, for instance, to casual games which offer immediate feedback) contributes to the appeal of the game to certain player types in the long-run. Thus, these kinds of games focus on the long-term motivation of core players in this genre of game, while other games motivate casual players through more immediate forms of feedback.

In all games, feedback is usually lucid, although the degree of straightforwardness differs from game to game. The aforementioned *Pocket City* applies positive reinforcement through simple, unambiguous accolades of players' actions via text boxes and audio-visual forms of rewards, as it is common in the realm of mobile and browser games. The aforementioned *Democracy 3* presents numerical data that are subject to interpretation.

A form of feedback embedded in the narration of the games comes from game world inhabitants. In *SimCity 4*, inhabitants can express their disagreement in protests (e.g., teachers' school strike) and radical actions (e.g., tearing down a water pump in polluted areas). *Cities: Skylines* includes a form of the social network "Twitter", therein called "Chirper", which is used to show the player with what certain citizens are satisfied or dissatisfied. The happiness-parameter, which is included in most of the examined management games, can be counted as additional means to transport the inhabitants' opinion.

When it comes to feedback, visualization (partly mixed with audiolization) plays a pivotal role: It makes the effects/consequences of players' decisions visible (and partly audible). The most obvious example is that if players decide to build something, the structure appears on the map. If the water in *Cities: Skyline* gets polluted, it turns brown. If problems occur, they are usually highlighted on the map through blinking, colors and signs. Visualization can be also seen as a form of didactic mediation in its own right. It (partly mixed with audiolization) not only illustrates the effects of players decisions, but also helps the player to understand the polytelic conflict/complex problem presented in the game and to make their own decisions to solve this problem by illustrating parameters, measures, and sometimes cause-and-effect relationships as a basis for their decisions, through graphics and graphs. It reduces complexity and offers players a systematic basis for decision-making.

Civilization VI: Gathering Storm, which focuses on climate change as gameplay mechanic after reaching the industrial era, is an interesting example. In this context, it must be considered that CO_2 emissions are in contrast to other forms of pollution not immediately visible to the human eye, which is one reason why, in reality, it is hard to convince people to change their behavior in the long run. The most important factors/parameters concerning climate change in *Civilization VI: Gathering Storm*—e.g.,

global mean temperature rise in degree Celsius, sea level rise in meters—can centrally be observed through the world climate screen (see Figure 4).

Figure 4. The world climate screen in Civilization VI: Gathering Storm (Screenshot).

However, the game does not only offer a visualized feedback to player's actions through the presentation of data, but also through the depiction of real consequence for humans, which are visualized on the game map—e.g., coastal tiles are flooded, storms can destroy parts of the cities. The game is able to show climate change as it happens through natural disasters, which requires a speeding up of time (see Section 4.2.3) and enables players to perceive climate change (through visual and audio channels) as causes of humans' manipulation of nature.

In all, feedback and visualization enable the consequences of players' decisions to be visible, which seems to be most relevant when considering effects that would, in the real world, be visible only after years or decades, or not visible at all. These tools reduce complexity and intransparency, which are characteristics of complex problems that require dynamic decision making. They also make polytelic conflicts more transparent, and thus, offer a better basis for decision-making.

In summary, the feedback to actions and decisions of players, as well as the visualization of the variables' states and cause-and-effect relations, improve players' understanding of polytelic conflicts and support their decision-making. They, therefore, contribute to the games' learning potential. Nevertheless, the way the relationship between measures and outcomes is revealed to the players also implies a risk from an educational perspective. When game designers share their knowledge about the models they built into the games with their players via feedback, i.e., allow them to easily reconstruct the models of their games, they oversimplify and reduce uncertainty. In reality, however, humans have to live with model uncertainty; the true models may remain unknown. Thus, games used as educational tools to enable an understanding of, e.g., models and decision-making risk to promote an overtly reductionist mindset. The application of games in educational contexts must, therefore, encompass a critical discussion of the underlying models in games vs. reality.

The final subsection of the analysis looks into another important design feature that codetermines players' gameplay experience; the modification of time.

4.2.3. Modification of Time

The passage of time in digital games is determined and modified by designers, as well as players. Time represented in games does not necessarily coincide with the time played—i.e., the represented time might run faster or slower than the time invested by the player (pacing). Additionally, players themselves are able to influence the passage of time. For instance, depending on the genre/game, they can speed up or slow down time, pause gameplay or—in the case of turn-based games—freely

decide about how long they take to let a certain time span (predefined by the game) pass. Overall, time modification takes place in two senses: By designers' pacing of the game and by players' codetermination of the passage of time.

In terms of game-based practice of decision-making, the factor of time is highly relevant, due to two reasons: (1) The way time is structured in the games codetermines the particular nature of challenges in problem-solving and decision-making; and (2) the modification of time, by the games (via *game design*), as well as by the players (via *play*), might contribute to processes of learning decision-making. (2) is true in three ways: (a) By showing players the effects of their decisions much earlier, as it would be the case in real-world scenarios, the games illustrate cause-and-effect relationships, thus, allowing players to analyze the consequences of decision-making in the context of polytelic conflicts; (b) by letting players decide on the passage of time, the games allow players to think through and review their decisions before and after making them, and thus, foster processes of reflection on decision-making and; (c) by allowing players to go back in time the games enable them to repeat/replay particular sequences of decision-making, and thus, facilitate not only a repetitive practice of decision-making, but also creative experimentation with multiple possible decisions.

In the remaining parts of this subsection, we offer examples of roles of time from our analyses for the aforementioned phenomena based on the categories "relation of play time and event time" and "action mode: real-time vs. turn-based". Thereby, the merit of time modification for the practice of decision-making will be demonstrated.

(1) Codetermination of the challenges' nature

Action mode, in the genre of strategy and management games, can be split into real-time and turn-based games. Real-time games are time-critical as players need to react fast to certain upcoming problems, the "clock is ticking continuously". Admittedly, they offer players the option to pause time, but then the player can only think about their next steps and decisions; meanwhile, the construction of buildings and other actions is not advancing until time is restarted.

In contrast, turn-based games (like *Civilization*) are not time-critical. Here, time is paused while the players take their turn, so problems do not advance whilst players attempt to solve them. Players can take as long as they want to think about a problem's solution and make their decision. Thus, they chose how long they take for a turn—i.e., players do not have to decide and act under time pressure. After players finish a round, the game time proceeds as predefined by the game, for instance, three months in *Democracy 3*.

Whereas, the challenge of real-time games, such as *Banished*, stems from, among other things, time pressure, the difficulty of turn-based games, such as *Fate of the World*, can be explained by other factors, such as the complexity of the system, which is much higher in *Fate of the World* than in *Banished*. Thus, the action mode and its inherent handling of time codetermine the challenge of the game.

The role of time pressure is twofold. Time pressure can reduce complexity and thereby make decision-making easier—players do not have the time to consider all available parameters, but are forced to concentrate on the number of parameters they are able to perceive and come up with a quick, intuitive decision. Additionally, in general, time-critical games tend to present problems that are clearer and include a lower number of parameters than turn-based games as they focus on a different kind of challenge. However, time pressure and accompanying information overload also makes it harder to make "good" decisions as part of complex problem-solving when the complexity of problems is high, because players may not have the time to consider unintended side-effects.

(2a) Illustration of cause-and-effect relations

Most strategy and management games included in our sample cover a relatively long period of time, playing out over the years to decades (with the exception of *Frostpunk*, a post climate change "city builder", which covers only days to a maximum of a few months). Therefore, these games have the ability to show the long-term effects of decision-making. This is especially relevant for our geographical

topics, as many of the effects of current socio-ecological challenges are only visible mid- to long-term. For example, anthropogenic climate change is a slow process that began decades ago; its effects, like sea-level rise, the change of average ground and air temperatures, the migration of plant and animal species, or an increase in extreme weather events, become recognizable in the long run. Causes and effects of challenges in the fields of urban development, resource usage and migration are likewise at least mid-term.

Juul [29] distinguishes between play time—i.e., the time the player plays—and event time—i.e., the time that passes in the narrative world of the game. This difference between play time and event time is relevant for the context of this research as it offers players the opportunity to get feedback on their decisions far more quickly than it would be possible to in reality. *Civilization VI: Gathering Storm*, for instance, allows players to observe the possible progression of climate change and lets players experience the influence of their decisions on the underlying system in a couple of hours. The acceleration of feedback illustrates cause-and-effect relationships and allows players to analyze the consequences of decision-making in the context of polytelic conflicts. It becomes apparent that this form of time modification enables games to present geographical problems in a condensed way, which makes them more dramatic, and thus, more interesting for players/students. Thereby, it increases their motivation which is pivotal for learning processes. Although these processes can, in general, be appreciated from an educational perspective, they also imply the risk of dramatization and scaremongering.

The gap between play time and event time is significant in all the games we have analyzed, but its size differs from game to game. In *Fate of the World: Tipping Point* each turn represents five years, whereas in *Democracy 3* a turn equals three months. In this case, these differing ratios seem to fit the central topics of the game. In the climate change simulation of *Fate of the World* bigger gaps between turns (i.e., five years) make sense because in the area of climate change the effects of human decisions and actions only play out in the medium- and long-term. Compared to other games, the faster progression of event time is suitable to show players the effects of their decisions on the development of climate change. In contrast, *Democracy 3* is based on smaller gaps between turns (i.e., three months) which makes sense as in this game players are asked to implement a broad range of policies, with some of them already yielding significant effects in the short-term.

(2b) Offering of time for reflection

In turn-based games, players have to codetermine the relationship between play time and event time themselves. In *Democracy 3*, each turn represents three months, no matter how long the player takes for each turn. However, most of the real-time games also allow the player to influence the relationship to a certain degree. First, in many games, the relationship is customizable—i.e., players can speed up or slow down the progression of time in the fictional world. In *Tropico 6*, for instance, the default relationship between play and event time is 30 seconds to one month, but the player can speed the game up to double or fourfold speed. In *Cities: Skylines* players can decide between three velocities: Normal (10 seconds = 1 day), medium (5 seconds = 1 day) or fast (2.5 seconds = 1 day). Second, in most of the games, players can pause time.

The possibility to modify the speed of the game does not only allow players to adapt the game to their own preferences and play styles, but also to use it as a strategic tool. They can slow down or pause the game when they need time for thinking and/or want to reduce time pressure, but they can speed the game up if they want to reach a quicker completion of buildings, for instance, or, more generally speaking, if they want to achieve a sense of achievement more quickly. From an educational perspective, the ability to customize time is interesting because players/learners can use it to personalize their playing and learning experience, as well as to reflect on their decisions.

In all, the absence of time pressure in turn-based games, as well as the possibility to weaken time-pressure (by pausing or slowing down time) in real-time games, can foster reflection before, during and after players make their actual decisions. In this sense, the games can act as facilitators of

Kahneman's [16] System 2 thinking (slow) which applies a more sophisticated rational decision process, in contrast to System 1 thinking (fast) which allows humans to decide quickly using their intuition. However, the occurrence of time pressure (as in *Papers, Please* in which the players' time to decide about the fate of immigrants, in the role of a border office, is extremely limited) is also interesting from an educational perspective, because many real world polytelic conflicts and complex problems must be solved under time pressure too—e.g., when the German chancellor Angela Merkel was confronted with immigration-related decision-making when thousands of immigrants were standing in front of the German border in 2015.

(2c) Offering of the possibility to repeat decisions and creatively experiment

A similar function is achieved through the repetition of tasks, including decisions when players reset time by loading earlier versions of the game state, which is possible in all games we have examined. Alvarez Igarzábal [37] argues in his work on time and space in video games that the more knowledge players gain through repetition, the better they "are at predicting the outcomes of events that involve those tasks" (p. 26). The author describes the Groundhog Day Effect which "is the result of the player travelling back in game time [which equals Juul's [29] event time] with knowledge about the future" [37] (pp. 26–27). Thus, games offer players the possibility to adapt their decision-making in a safe space, enabling them to try out a variety of different decisions, learn about their effects on the system and possibly correct previous decision-making, which can be seen as another learning mechanic for the practice of decision-making. In addition, to facilitate the repetitive practice of decision-making, the possibility of "time travelling" also fosters creative experimentation with the possibility of a number of decisions, e.g., when players adopt/try out different perspectives from political philosophy in *Democracy 3* [31].

Overall, the modification of time supports the practice and learning of dynamic decision-making in two ways: (1) The representation of a timespan that covers years to decades (event time) in much shorter play sessions (play time)—i.e., the acceleration of time and feedback—illustrates players the effects of decision-making that would otherwise take weeks, months, years, decades and; (2) the possibility to decide about the passage of time themselves (through various techniques, e.g., deciding about the end of turns, slowing down the game speed, pausing and replaying) allows players to think and reflect about their decisions (before, during and after decision-making) and to repeat and experiment with decisions.

5. Conclusions

The research presented here examined how digital strategy and management games facilitate the practice of dynamic decision-making from an educational perspective. Based on a comparative qualitative analysis of 17 commercial entertainment games, organized into categories derived from a theoretical model of decision-making design, the article explained two ways in which strategy and management games can help to teach decision-making in the context of geography education: (1) The core gameplay loop of strategy and management games implies dynamic decision-making as players must take over the role of a decider and solve polytelic conflicts—i.e., situations in which players must pursue different conflicting goals—by making a continuous series of decisions on a variety of actions and measures, whereby real problems relevant for geography education, such as climate change and urban development, are simulated and; (2) structural features of strategy and management games—seen as techniques of didactic mediation—foster processes of learning where players' practice of decision-making is structured by typical features of games that make the process of decision-making more transparent and digestible, such as the curation of possible decisions, the offering of lucid accelerated feedback to players' decisions and actions (as part of the gameplay loop) and the modification of time, including not only the pacing of the games by the designers, but also the options for players to codetermine the passage of time.

All three identified techniques of didactic mediation mitigate the complex problems and polytelic conflicts—i.e., make them comprehensible—by moderating some of their characteristics, such as conflicting goals, complexity, connectivity, intransparency and time. In general, all analyzed games offer a balanced relationship between a difficult, challenging polytelic conflict and mitigating factors. Both sides contribute to the enjoyment of playing a game and to the games' learning opportunities. In addition, the games' open world settings offer space for individualized learning. These are the main reasons why these kinds of games are good educational tools for the practice of dynamic decision-making.

However, the paper also emphasized the games' shortcomings in terms of their educational merit. In particular, it identified the extensive framing of players' decisions by restricting the numbers of choices, as well as by rewarding certain choices more than others, in accordance with the logic of "games as competition".

Therefore, an educational application of the games must, by all means, entail a critical reflection about the decision-making conditions within the games, with particular focus on players' limited choices inside a biased game system. Teachers who apply those games in educational contexts must make sure that students understand the difference between the simulation of the games and reality. However, from an educational point of view, this should not be seen as a burden, but rather as an opportunity—it is the comparison of the differences between the simulation and its real-life models that can serve as a starting point for a reflective examination of complex problems, polytelic conflicts and decision-making relevant to geography education.

Such an analysis could begin with an investigation of the main characteristic of polytelic situations in terms of conflicting goals. With regard to the realm of transportation planning and quality of life, for instance, teachers could ask students (as players) to look into (and thus, experience) the complicated relationship between economic, environmental and cultural goals as depicted in current city building games—all of them influencing the happiness of city dwellers in different ways. These observations might then be compared with planning documents, newspaper articles or academic sources, including surveys on happiness. In this context, it could also be worthwhile to discuss to what extent the games adequately represent the different positions of diverse groups with conflicting interests (e.g., in the case of the example: Commuters vs. city residents). The techniques of didactic mediation, reconstructed in this study, support these kinds of reflective processes because they make polytelic conflicts transparent, identify important aspects and offer room for reflection (as explained above). In addition, they can be categories for such a comparative analysis themselves and lead to important questions, such as: How realistic are the scopes of decision possibilities inside the games? Are bike lanes, referring to the example above, even an option in city building games? Are particular decisions favored by the games? Is it, for instance, possible to successfully implement a Copenhagen-style transportation infrastructure or do the games solely reward approaches centered on the automobile? (*scope of possibilities*) How do decisions of transportation planning actually influence the quality of life of people in the games vs. reality? (*effects and feedback*) To what extent does time modification influence players' assessment of phenomena? Do games include meaningful data on, e.g., the development of traffic jams, pollution, accidents over time that can inform decision-making? (*time*) Finally, another important point for discussion should be the obvious lack of democratic negotiation processes which are necessary for the reality of politics, public administration, businesses etc., but mostly absent in games where the players act as the sole decider and do not have to negotiate their decisions.

Based on a qualitative analysis of 17 digital strategy and management games, the present study developed a theory of how games may help to facilitate the practice of dynamic decision-making. The main limitation of this study is that it did not empirically measure to what extent these learning opportunities actually lead to learning processes and outcomes on the part of the players. Overall, there are various possibilities for further research.

Future studies on the practice of dynamic decision-making in strategy and management games should, for instance, look closer at the scope of in-game decision possibilities, as well as the effects

of players' actions with a particular focus on topics that are relevant for schools and instruction (including those selected for the present study) from the perspective of different subjects (including, but not limited to, geography). It should be examined as to what extent the modelled systems and decision-making processes are accurate in terms of the current state of knowledge in the disciplines. Empirical studies should also explore players' actual decision-making in the games (i.e., the process of deciding and the decisions as such)—when they play for leisure, including processes of informal learning. In this context, it is of particular interest to quantitatively measure to what extent those games influence and manipulate the decision-making of their players. Furthermore, it should be discussed to what extent the practices learned in the games are principally transferable to out-of-game contexts. From the perspective of applied education sciences, most importantly, educational processes that occur when the games are used as a tool to practice and reflect on decision-making in formal (and non-formal) educational contexts must be examined carefully.

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