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"On the Use and Abuse of Gamification as a Design Strategy for Geospatial Applications. Illustrated by Means of the 'Atlas of Philosophical History' Prototype."

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Kurzfassung/Abstract

Die vorliegende Arbeit widmet sich der Analyse des Potenzials und der Problematik von Gamification als Designstrategie für Applikationen im Bereich der Kartographie und GIScience. Es wird neben einer Diskussion der relevanten Definitionen und Abgrenzungen zu anderen und ähnlichen Konzepten, wie „Serious Games", „Edutainment" und „Games with a Purpose", versucht, zu zeigen, durch welche theoretischen Grundlagen und Annahmen der Einsatz von Gamification legitimiert wird, auf welche Frameworks für das Design und die Implementierung zurückgegriffen werden kann sowie mit welchen empirischen Ergebnissen in Bezug auf die Wirksamkeit oder auch Unwirksamkeit dieses Konzept aufwarten kann. Neben dieser allgemeinen Diskussion wird versucht, zu klären, in welchen Bereichen Gamification und ähnliche Konzepte im Fachkontext Verwendung finden und wie es in Hinblick auf die Qualität der theoretischen Rückbindung sowie der Nutzung von etablierten Frameworks um die Verwendung dieser Konzepte bestellt ist. Es wird gezeigt, dass sich nicht nur die von einer der größeren bestehenden Literaturanalysen diagnostizierte Kluft zwischen Theorie und Anwendung von Gamification im Fachkontext wiederfindet, sondern auch, dass eine doppelte Beschränkung hinsichtlich der Nutzung von Gamification als Designstrategie in diesem Bereich vorherrscht. Um zu der Behebung dieser doppelten Beschränkung in Bezug auf die Anwendungsszenarien und die benutzte Gamificationstrategie einer „reward-based" oder „pointsified" Gamification sowie zur Schmälerung der Kluft zwischen Theorie und Anwendung beizutragen, wird einerseits versucht, durch eine Analyse der theoretischen Anschließbarkeit von Gamification an konkrete Konzepte und Forschungsfelder in der Kartographie und GIScience für das Potenzial von Gamification in diesen Bereichen zu argumentieren und möglicherweise auch neue Anwendungsszenarien zu inspirieren. Andererseits wird durch ein erweitertes Framework für das Design von gamifizierten Geo-Applikationen nicht nur ein Instrumentarium für eine bessere Auswahl und theoretische Begründbarkeit der Verwendung von Game-Design-Elementen im Entwicklungsprozess in die Hand gegeben, das Framework wird auch exemplarisch zur Erstellung einer gamifizierten web-basierten kartographischen Applikation, dem „Atlas of Philosophical History", herangezogen.

This thesis focuses on the analysis of the potential and problems of gamification as a design strategy for applications in the area of cartography and GIScience. Besides discussing the relevant definitions and demarcations to other related concepts like "serious games", "edutainment" and "games with a purpose", an attempt is made to not only outline theoretical underpinnings and presumptions legitimating the utilization of gamification and frameworks used for designing and implementing gamification, but also to demonstrate empirical findings regarding the effectiveness of the concept. Apart from a general discussion, areas of application of gamification and related concepts within the domain of cartography and GIScience are analyzed and the quality of theoretical ties as *well as the use of established frameworks is examined. It can be shown, that not only the findings of a major literature review — diagnosing a gap between theory and action in gamification research — could be confirmed, but a duplexity of limitations regarding the use of gamification in the domain of cartography and GIScience is prevalent. Contributing in the overcoming of the duplexity of limitations regarding application scenarios and the used "reward-based" or "pointsified" gamification strategy as well as bridging the gap between theory and action, an analysis of the theoretical compatibility of gamification to specific concepts and research fields within the domain of cartography and GIScience is conducted in order to argue for the potential of gamification in these respective fields and possibly inspire new application scenarios. Additionally, with the help of an extended framework for the design of gamified geo-applications, not only an instrument for a theoretically guided selection and justification of game design elements is provided, but the framework is also applied to inform and guide the design of a gamified web-based mapping application, the "Atlas of Philosophical History".*

"[…] The influence of SimCity is greater than that of academic geography, both in terms of the numbers of users, and in terms of the initial appeal of its 'message'."

Adams,1997

"Games are the only force in the known universe that can get people to take actions against their self-interest, in a predictable way, without using force."

Zichermann, 2010

1 Introduction

As the opening quotation by Gabe Zicherman — infamously labeled "the dark lord of gamification" by game designer and theorist Ian Bogost — suggests, games seem to emanate inexplicable power, power not only to captivate or "suck" people "in", but also to drive them to perform predictable acts not necessarily in their best self-interest. It is exactly for these presumed motivational powers that scientists, designers and businessmen started to take a serious look at play and games as well as their potential to use them in other settings than mere entertainment — ambitions that found their expression institutionally in the formation of "game studies" as a new discipline and conceptually in the development of a series of interrelated notions like "edutainment" (RAPEEPISARN et al. 2006), "games with a purpose" (AHN 2006), "serious games" (RITTERFELD et al. 2009) and "gamification" (DETERDING et al. 2012). Accompanying, or even accelerating these developments is the increasing cultural and economic importance of a relatively young medium: the video game. Its revenues surpass those of the music and film industry combined (TSUKAYAMA 2014) and some theorists even propose the thesis of a general "ludification of culture" (RAESSENS 2006).

A shift of power from organizations to individuals — in terms of which media products are consumed and when — has led to an increasing importance for organizations and institutions to motivate users at an individual level, to entice them rather to rely on their former power to structure user behavior (RIGBY 2014). This increasing need for organizations to understand the motivations of their customers and reach out to them finds its analogy in the world of cartography and GIScience, as the ubiquity and availability of free to use web maps and geographic data in general not only diminishes the importance of central national mapping agencies and private publishing houses, but also — going hand in hand with the rise of (geo-)web 2.0 — mapping and the use of geospatial technologies became within reach for everyone, a development described as "neogeography" (TURNER 2006). Far from being mere "sensors" (GOODCHILD 2007) utilized for data collection, citizens actively take part in mapping processes, as collaborative mapping projects like OpenStreetMap show.

Although, as it will be shown later, a meticulous conceptual differentiation between the two main notions — serious games and gamification — is not feasible, this thesis will focus on gamification, the use of game elements and mechanics in non-game contexts (DETERDING et al. 2012)[1]. Drawing upon psychological theory (e.g. RYAN/DECI 2000, SKINNER 1953, CSIKSZENTMIHALYI 1988) gamification has already become a viable design choice in many domains, including marketing, education, crowdsourcing and health — the basis intention being to engage and motivate users through implementation of game elements and mechanics into interactive systems (SEABORN/FELS 2015).

1 In contrast, serious games arguably use "full-fledged games" for non-game contexts (DETERDING et al. 2012).

A cursory overview of the literature on gamification and related concepts like serious games in the context of cartography and GIScience shows that — apart from early work, completely detached from gamification and the theory behind it (e.g., TAYLOR 2003, CARTWRIGHT 2006) — the vast majority of literature revolves around the topic area of volunteered geographic information (VGI) (GOODCHILD 2007), crowdsourcing and geographic data collection (e.g., ODOBAŠIĆ et al. 2013, KELLER 2013).

From a methodological point of view, most use cases of gamification within this domain seem to be still dominated by a design strategy referred to as "pointsification" (ROBERTSON 2010). At its core, such a "one-size-fits-all" design focuses primarily on the use of a simple set of game mechanics or interface elements — namely points, badges, leaderboards and achievements. Apart from showing a lack of creativity and an arguably repetitive look and feel of results, a perspective more concerned with the actual power to engage users and change their behavior criticizes such a reward-based design strategy for its possible detrimental effects on long-term user engagement and intrinsic motivation to use a product (NICHOLSON 2012).

As an extensive survey on gamification and its application in many domains shows (SEABORN/FELS 2015), the mere superficial reference to gamification concepts, often without regarding their theoretical underpinnings or design frameworks — described by the authors as "gap between theory and action" — seems to be not only the case within the geospatial community. Against this backdrop, it seems advantageous to assist in closing the gap in the domain of cartography and GIScience from both of its sides while tackling the aforementioned shortcomings in terms of limitations in usage scenarios and design strategies.

Therefore, it is first necessary to gain a deeper theoretical understanding of gamification, its underlying theoretical principles and frameworks. The potential and problems of gamification as a design approach in general and for geospatial applications in specific have to be identified in order to assess whether, how and to which degree gamification may be suitable as a design strategy. Existing frameworks have to be further examined regarding their applicability and usefulness and, if necessary, extended or altered to fit the needs of applications in the domain.

In order to contribute in overcoming the limitation is usage scenarios, the (often implicit) conceptual ties between fields of research in cartography or GIScience and gamification have to be rendered visible, as their overlaps may inform future research paths or even extend the space of possibilities for application design. Possible concepts or fields of research susceptible to such endeavor include, for instance, multimedia cartography — due to its conceptual call for utilizing different media (elements) —, cartographic interaction design — game design may be merged into game interaction design to a high degree — as well as narrative cartographies — narrative elements are also centerpiece elements in gamification design.

As a part of this thesis an application is developed to not only provide a usage context outside the aforementioned ones, but also to attempt to utilize — building on gained theoretical insights regarding gamification and its conceptual ties — an extended framework for gamification design. The application — an interactive mapping application for the exploration of philosophical history — thus pursues a design strategy that avoids the methodological restriction to pointsification by employing a diverse set of game design elements, supporting the goals and tasks of the application.

To summarize, the thesis will try to find answers to the following research questions:

I. *What are the potentials and problems of gamification as a design strategy for geospatial applications?*

II. *How — both in theory and practice — can gamification be utilized to potentially improve the design of geospatial applications?*

  II.I. *Which conceptual overlaps to existing fields of research in cartography and GIScience exist? How can a framework for the design of gameful geospatial applications be constructed out of existing frameworks and theoretical set pieces?*

  II.II. *How can — built on this framework and possible theoretical points of contact — a gamified web-application be developed?*

The remainder of this thesis is structured as follows: The first chapter covers basic definitions of game, play, cartography and GIS(cience) as well as a preliminary classification system for the (potential) body of work in the respective areas of overlap. This is necessary to not only lay the groundwork for understanding the notion of gamification and subsequent research fields within the domains of cartography and GIScience, but also to situate this thesis itself in the potential body of work. The next chapter summarizes the results of an intensive literature review on gamification, its theoretical underpinnings, strategies of implementation as well as potential, problems and critique of the concept in order to partially answer the first research question.

It is not until the following chapter, that the use of gamification and its related concepts within the domain of cartography and GISience is examined. After this outline of the body of work on gamification, emphasis is put on the conceptual overlaps between cartography, GIScience and gamification to synthesize the potential of gamification in these respective sub-fields and inform future research agendas, thus attempting to answer both the remaining part of the first research question, and the first part of the second one. In the remainder of the chapter an adapted framework for the design of gamified geospatial application, drawing mainly from gamification design literature and cartographic interaction design, is introduced. This framework is applied in the last main chapter to inform and guide the development of "the Atlas of Philosophical History" — a web-mapping application for exploring the history of philosophy — utilizing open-source data and software libraries.

2 Game, Play and GIS(cience)

The following chapter introduces the fundamental concepts for the remainder of this thesis: game, play, cartography and GIS(cience). First, an attempt is made to define, or at least outline, the basic characteristics of the concepts of game and play. Focusing on games, the question regarding the differences between analog and digital games will be covered. Furthermore, the primary field of interest, cartography and GIS(cience) is outlined in order to finally chart three research avenues out of potential intersections between the two fields of games and GIScience. These research paths will allow not only to coarsely systematize the existing body of work but also to situate gamification and this very thesis within one of these paths.

2.1 Game and Play

HUIZINGA's (2000) *Homo Ludens* can be considered as *the* classical work on play. In his essay the author argues that play is fundamental to human civilization and tightly-knit with culture. As the title suggests, *Homo Ludens (*man the player) should be made a concept alongside other anthropological concepts like *Homo Faber* (man the maker), *Animal Rationale* (rational animal) or *Zōon Politikon* (political or state-building animal). Attempting to introduce formal characteristics of play, HUIZINGA proposes the following elements of a definition:

- *Play is primarily a voluntary activity*: play is a voluntary activity for the purpose of enjoyment, if forced it ceases to be play (p. 7).
- *Play is not ordinary or real life*: play is rather an own sphere with its own disposition. In the notion of "pretending" lies the consciousness of inferiority of play compared to serious activities (p. 8). Contrasting ordinary life, it lies outside and even interrupts the process of immediate satisfaction of needs (p. 9).
- *Play is secluded and limited*: play takes "place" within certain limits of space and lasts a certain time (p. 9).
- *Play is repeatable*: play can be repeated at will. Not only play itself but also its mechanics are repeatable (p. 10).
- *Play is rule-bound*: within its confines regarding space and time, order reigns. If order is broken, a play is destroyed (p. 10)

In a critique of HUIZINGA's definition the French sociologist CAILLOIS (2001) proposes two additional elements:

- *Play is make-believe*: Playing encompasses awareness of second realities set against real life (p.10).

- *Play is unproductive*: through playing nothing is created (e.g. goods, wealth) nor does the starting situation differ from the end of a game (p. 10).

CAILLOIS (2001) also classified games alongside two poles, which were later also used in game studies to distinguish the concept of “playing” and “gaming” from one another (see DETERDING et al. 2011): *paidia* and *ludus.* Whereas *paidia* refers to a principle of uncontrolled fantasy and free improvisation — an expressive, improvisational and even anarchic activity (e.g., a child’s play) —, *ludus* on the other hand characterizes an activity bound with imperative convention, i.e. rule-based and goal-oriented (CAILLOIS 2001, p.13). So HUIZINGA’s formal definition of “play” is arguably settled more on the ludus pole.

More recent definitions of game — thus focusing on the *ludus* aspect — take up elements proposed by HUIZINGA and CAILLOIS and mainly confirm their definition with slight variations. For JUUL (2005) a game is a bundle of necessary conditions:

> *“A game is a rule-based formal system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome, the player feels attached to the outcome, and the consequences of the activity are optional and negotiable.”*

Notably, these conditions are not thought of as sufficient. Furthermore, it is interesting to see the role of consequences of a game, which were explicitly denied in CALLOIS’ definition.

SALEN and ZIMMERMAN (2004) define “game” similar but with an emphasis on conflict:

> *“A system in which players engage in an artificial conflict, defined by rules, that result in quantifiable outcome.”*

MCGONIGAL (2011) argues that, abstracting from different game genres and technological issues, all games encompass the four following features (p. 21):

- *Goals*: a goal is providing a purpose in the form of a specific outcome players are working to achieve
- *Rules*: rules set limitations on ways to achieve a given goal
- *Feedback Systems*: provide motivation in the form of giving information on how far the player is from reaching the goal
- *Voluntary Participation*: players have to accept willingly the goals and rules of the game, as their freedom is reason for the experience of a game as a safe and fun activity

Other features like for example narratives, interactivity or virtual environments are not defining features but enhancing the four core features (p. 21) — very much like in the definition given by JUUL (2005).

Both SALEN/ZIMMERMAN (2004) and MCGONIGAL (2011) are drawing elements of their definition from the philosopher SUITES (1978), which claims to give necessary *and* sufficient conditions for every (possible) game (p. 55):

> "*To play a game is to attempt to achieve a specific state of affairs [prelusory goal], using only means permitted by rules [lusory means], where the rules prohibit use of more efficient in favour of less efficient means [constitutive rules], and where the rules are accepted just because they make possible such activity [lusory attitude].*"

The four terms in the square brackets, i.e. prelusory goal, lusory means, constitutive rules and lusory attitude are considered elements of a game, whereas lusory attitude (Latin ludus game) unifies the other ones in the definition (p. 35). Note that the four elements are nearly identical with MCGONIGAL's features of a game.

An example for an instantiation of his definition SUITS is giving throughout his book is that of golf: Golf is about getting a ball into a hole (*prelusory goal*), using a golf club to do so (*lusory means*). Although it wold be easier to put it there with your hand, it is forbidden (*constitutive rules*). If one would carry the ball with the hand and put it into the hole, one would not accept the rules and made the activity of golf pointless (*lack of lusory attitude*).

An obvious problem with concepts trying to give necessary or necessary and sufficient conditions for games arises from the notion of formality itself: what is gained by reducing a plethora of phenomena to very abstract conditions? Furthermore, it is even doubtable, that such conditions, true for *every* kind of game, can be given. A famous example for this view is the philosopher WITTGENSTEIN (1958, 66). In his *Philosophical Investigations* (Philosophische Untersuchungen) the philosopher develops his concept of "language-game" (Sprachspiel) using games as an example and metaphor for terms in general:

> "*[...] To repeat: don't think, but look!—Look for example at board-games, with their multifarious relationships. Now pass to card-games; here you find many correspondences with the first group, but many common features drop out, and others appear. When we pass next to ball-games, much that is common is retained, but much is lost.—Are they all 'amusing'? Compare chess with noughts and crosses. Or is there always winning and losing, or competition between players? [...] And we can go through the many, many other groups of games in the same way; can see how similarities crop up and disappear. And the result of this examination is: we see a complicated network of similarities overlapping and criss-crossing: sometimes overall similarities, sometimes similarities of detail.*"

For WITTGENSTEIN there is neither a common essence nor a principal characteristic to games (and terms in general), games are therefore incommensurable (POSSELT/FLATSCHER 2016, p. 146) and only describable as a network of similarities. This network is characterized by WITTGENSTEIN with the term “family resemblance”: like resemblances between members in a family, characteristic features can not often be pointed out, or may not even present at every member of the family (1958, p. 67). However, the lack of a common essence or exhaustive definition is no insufficiency, as it leaves us open for the plethora of phenomena labeled “games” and does not prevent us from meaningfully use the term.

Taking WITTGENSTEIN’s thoughts seriously, the term “game” has not to be defined rigorously in order to be practical. Maybe the lack of an exhaustive definition, if we leave WITTGENSTEIN’s strong theses on the nature of language behind, can also be considered as a consequence of the fact that play itself is an irreducible category of human nature, as HUIZINGA proposed, and as such it is always dissolved in human behavior and cannot be strictly separated from it to be defined rigorously.

2.2 Games versus Video Games

At first glance it seems that video games can be conceptualized as yet another type of game alongside, for example, board games. This is, broadly speaking, the perspective of game designers, as the focus of design lies arguably in the creation of player *experience*, not intrinsic to a specific technology or medium (FULLERTON 2014, p. 1 / SCHELL 2015, p. 10). In the academic field of video game theory, different theoretical positions for understanding video games have been developed as well. Traditionally, two positions may be distinguished: for the approach of *narratology* video games can be understood as interactive stories with protagonists and narrators, whereas the approach of *ludology* — similar to the perspective of game designers — conceptualizes video games as digital versions of an analog game like, for example, a board game. Both approaches treat video games as something that is independently depictable from a computer (cf. GÜNZEL 2012, p. 16), which lead to critique and attempts to synthesize both approaches (e.g. AARSETH 2001, p. 161). The main point of critique to be uttered, was that both approaches leave out a central characteristic that constitutes video games as a medium sui generis: its spatiality, i.e., in the case of video games, the motion of a player in a “video-game-space” (GÜNZEL 2012, p. 27-29). Necessary for this space within an image (p. 31), is a machine, simulating reality, and a medium, making this virtual reality appear. The depicted space, however, serves not only the purpose of viewing the image, but to combine image viewing with object interaction (p. 78). Furthermore, video-game-space itself may be a necessary condition of not only progressing through a game narrative but of all aesthetic qualities of the game, thus exceeding mere functionality (cf. EICHHORN 2007, p. 230).

Far from being comprehensive, such an excursus shows not only how video games can be conceptualized as distinct media, but also how contemporary video game theorists with their focus on spatiality, may, in an artifact-based view, provide theoretical linkage to research in the fields of cartography and GIScience (see Ch. 2.4.1 and 2.4.2). Gamification, as the use of game *elements*, arguably pursues a design-oriented perspective, understanding itself as a "transmedial category", therefore "blurring the distinction digital versus non-digital" (DETERDING et al. 2012, p. 11).

2.3 Cartography, GIS and GIScience

Traditionally, cartography deals with the creation of maps and map related representations, in a broad sense, with "any activity in which the presentation and use of maps is a matter of basic concern" (ROBINSON et al. 1995, p. 9). This includes not only processes of geographical data collection and manipulation, the design and distribution of maps, but also skills of map use and the study of maps (ibid.). Central intellectual object bringing together these diverse activities associated with cartography is arguably the map (ibid.)[2]. With the transition from analog to digital cartography, however, the conceptualization of cartography's central metaphor changed from static graphical representations to interactive and dynamic geographical data interfaces (MACEACHRAN/KRAAK 2001):

> *"Modern cartography, thus deals with a complex process of geospatial information organization, access, display, and use — with 'maps' no longer conceived of as simply graphic representations of geographical space, but as dynamic portals to interconnected, distributed geospatial data ressources."*

Today, an increasing extension of the map metaphor is observable, as maps are not only combined with multimedia and multisensory[3] elements, as well as increasingly designed and delivered on the internet (NEUMANN 2008), but also questioned regarding their status as objective and neutral artifacts (see Ch. 4.2.5), which in term shifted research foci from the stable artifact "map" to its relation to spatial knowledge production (CRAMPTON 2010, p. 3) and mapping practices themselves (KITCHIN/DODGE 2007, see Ch. 4.2.6). On the other hand, the actual practice of map creation, encompassing processes of geo-data acquisition, management and output — executed traditionally by cartographers — is now incorporated into geographic information systems (GIS), leading to an increasing convergence between cartography and GIS — institutionally reflected in the turn of mapping agencies towards GI-systems (cf. VAN DER WEL 2001, p. 27) or the explicit linking of cartography and GIS in cartography textbooks (e.g., ROBINSON et al. 1995). The term "GIS" may not only refer to the technological and institutional assemblage, but to a science surrounding GI-systems: Geographic Information Science (GIScience) (GOODCHILD 1992). From this perspective, cartography may be considered to be a (specific) part of GIScience, although authors like CRAMPTON (2010), in his

2 A view held as well by more contemporary theorists of cartography: For example, argues TAYLOR (2005, p. 6), leading exponent of the concept of cybercartography, for the map as "the central organizing principle of cybercartography".

3 These ideas are explicitly expressed in the concepts of Multimedia Cartography and Cybercartography (see Ch. 4.2.1).

broad understanding of mapping as "a human activity that seeks to make sense of the geographic world", understand GIS, cartography or any sciento-technological assemblage, as part of an "mapping tradition that exists in every moment" (ibid., p. 12). If an emphasis on differences between and feature characteristics of GIS and cartography is laid, a common view entails that cartography presents a more subjective and artistic, and GIS a more objective and scientific side of geographic information technology (cf. GOODCHILD n.d., TAYLOR 2005, p. 4).

In this thesis, a broad and interconnected understanding of cartography and GIS(cience) is envisaged. However, the map as central metaphor, as well as mapping processes and practices stay key focus area.

2.4 Possible Avenues of Research

In the following, three possible avenues of research with respect to the relationship between game, play, maps and mapping are pointed out: maps *in* games, maps *as* games and *games in* maps. Notably, both the word pair "game" and "play," as well as "map" and "mapping", should be thought of as designating the artifact and the activity, respectively. Both, the artifact and the activity, are included within this classification. Although, "play", is settled more on the ludus pole with respect to CALLOIS' (2001) definition (see Ch. 2.1) (e.g., in "playing a game"). Additionally, the outlined avenues of research are neither exhaustive (additional research thrusts are possible), nor disjunctive (overlaps between avenues of research are possible), but do serve their purpose as heuristic tools to organize the (possible) body of work in a generalized fashion.

2.4.1 Maps in Games

The first avenue of research is concerned with maps or mapping practices in games or video games. Such a perspective might involve analyzing the role maps or other spatial representations play in different video or board games (e.g. CHĄDZYŃSKA/GOTLIB 2015, CHAMPION 2007, GÜNZEL 2012, EICHHORN 2007), possibly not only focusing on the use of the maps by the players, but also on their design and aesthetic qualities (e.g., PERKINS 2009). One attempt to differentiate the different functions geospatial visualizations may have in video games, carried out by EICHHORN (2007), is summarized in Table 1. Additionally, approaches may be concerned not so much with the artifact "map", but focusing instead on the act of mapping itself as part of (video) games (e.g., LAMMES 2008) or the relationships between the "real" world or space and the world or space depicted in video or hybrid location-based games (e.g., LAMMES 2011). Mapping practices may not only be investigated regarding the role they play *within* the game, but also in the surrounding game ecology, e.g., the review or design of game maps, the production of machinima[4] (GREENSPAN 2005) or mapping of game routes or locations of

4 DETERDING et al. (2012) label such wider game practices in general *serious gaming* (see Ch. 4.1.2).

game artifacts (EICHHORN 2007)[5]. This avenue of research might contribute to the empirical derivation of a typology of play with or on maps, which, in term, can be used for playful cartographic interaction design (see Ch. 4.2.2). Further, the often unorthodox and stylish design of game maps may inspire or even anticipate the design of maps and mapping applications.

Types of Visualization	**Games**	**Functions**
Navigation elements: compass/minimap/world map	Farcry; GTA: San Andreas	orientation
Topography	Monkey Island 3	expository nature (“Expositorischer Charakter”)
Thematic map	Victoria – An empire under the sun; Birth of America	countries/borders; perspective/ (geo-)politics
Overlays (augmented reality)	Diablo 2	orientation/repository of knowledge (“Wissensspeicher”)
Maps in discourses (“Karten in Diskursen”)	World of Warcraft; GTA: San Andreas	map as game manual; player as amateur cartographer

Table 1: Functions of geospatial visualizations in video games (after EICHHORN 2007, p. 233)

2.4.2 Maps as Games

Alternatively, maps, other spatial representations, or even cartography and GIScience as a whole can be examined regarding their similarities or common ties to games and play. Such a line of research may correlate game patterns and geographic concepts (e.g., AHLQVIST/SCHLIEDER 2018) or look for similarities, analogies or converging themes between the respective fields, often focusing on technology or on attempting to outline the potential of games for the field of interest (e.g., SHEPHERD/BLEASDALE-SHEPHERD 2009, AHLQVIST 2011). Beyond that, mapping practices themselves can be conceptualized — although arguably “only” metaphorically — as *playful.* For example, investigates PERKINS (2013) in his “ludic approach” to mapping, how “mapping technologies call particular playful encounters with the world into being” (PERKINS 2013).

2.4.3 Games in Maps

An approach labeled “games in maps” is concerned with the *use* of games or play — in the widest sense — for map design and practices. Possible research thrusts within this perspective encompass the use of game technology (e.g., game engines) for mapping applications or geovisualization (e.g., HENRY 2018), as well as the use of full-fledged

5 This corresponds with EICHHORN‘s (2007) m*aps in discourses* type of visualization (*See Table 1*)

games (serious games) or game elements (gamification) for purposes within the domain of cartography and GIScience. The work in hand, as it deals primarily with gamification, is therefore situated within this approach.

In the following chapter, the concept of gamification in general is discussed in greater detail. A fine-grained differentiation and discussion of contributions in the context of cartography and GIScience up to now is presented in Chapter 4.1.

3 Gamification

3.1 Precursors

The term "gamification" was coined 2008 and adopted more widely in 2010 (DETERDING et al. 2011), therefore many divergent definitions exist. The concept itself is not new and had many precursors like the gamification-of-work movement — namely in a period from the early to mid 20th century in the Soviet Union and starting from the 90s until the early 2000s in the West (NELSON 2012). In the Soviet Union the basic idea was to motivate workers through other incentives than money, which was regarded capitalist. Several experiments were conducted, including awarding factories for their performance with points or workers with specific medals, contests were held between teams regarding, for example, which team could finish building a bridge faster (p. 4). In the United States, beginning in the 1990s, management consultants tried to find "free" performance bonuses utilizing non-monetary incentives as well as to harness worker productivity, impossible to get only through traditional money-based incentives. Several books were published with the notion of introducing fun into the workplace, e.g., through turning corporate training seminars into games or setting up games for work goals or contests between employees (p. 4). Other precursors included marketing efforts like point cards and reward memberships or loyalty programs (e.g., frequent-flyer programs) (CUNNINGHAM/ZICHERMANN 2011). The tradition more related to the concept of "serious games" — the use of games for "serious" purposes — goes back at least centuries as different military training games show (DETERDING et al 2011, p.10).

3.2 Definitions

Although gamification can — in a broader context — be regarded as "a general process in which games and playful experiences are understood as essential components of society and culture" (FUCHS et al. 2014, p. 7), the proposed use of the term within the scope of this thesis refers to a narrower description of the term, as it was developing since the early 2000s. Arguably the most cited definition of gamification was given by DETERDING et al. (2011, p. 11):

> *"'Gamification' is the use of game design elements in non-game contexts"*

DETERDING et al. are explicitly referring to CALLOIS' distinction between paidia and ludus in using *game* design elements, therefore settling the gamification concept on the ludus pole (p.11). It is furthermore proposed to use the terms "*gamefulness*" to refer to the "experiential and behavioral quality" of gaming, "*gameful interactio*n" to "artifacts affording that quality" and "*gameful design*" as "designing for gamefulness" by use of game design elements. Gamification is thought of as usually coinciding with gameful design, differentiated only in so far as gamification could be seen as the design strategy of using design elements and gameful design as the goal of designing for gamefulness (p.11).

The focus on the use of design *elements* in the definition of DETERDING et al. is used to differentiate the concept of gamification from “serious games”, which use *full-fledged* games for non-entertainment purposes. Additionally, it is proposed to constrain the term “gamification” to the use of game *design*, not game-based technologies or other practices in a wider ecology of games (p.12). Game design elements can be identified on different levels of abstraction (see Table 2) ranging from interface design patterns, game mechanics, game design principles to game models and design methods. In section 3.5 these different hierarchical levels will be discussed in further detail.

Level	Description	Example
Game interface design patterns	Common, successful interaction design components and design solutions for a known problem in a context, including prototypical implementations	Badge, leaderboard, levels
Game design patterns and mechanics	Commonly reoccurring parts of the design of a game that concern gameplay	Time constraint, limited resources, turns
Game design principles and heuristics	Evaluative guidelines to approach a design problem or analyze a given design solution	Enduring play, clear goals, variety of game styles
Game models	Conceptual models of the components of games or game experience	MDA; challenge, fantasy, curiosity; game design atoms; CEGE
Game design methods	Game design-specific practices and processes	Playtesting, playcentric design, value conscious game design

Table 2: Levels of game design elements, ordered by level of abstraction (DETERDING et al. 2011, p. 12)

HUOTARI and HAMARI (2012, p. 19) propose a definition from a service marketing perspective, which claims to circumnavigate problems arising with the definition given by DETERDING et al. (2011). Especially the focus on game elements is criticized, as there is (i) no set of elements that is unique to games and (ii) it is not ensured that the application of these elements automatically lead to gameful experiences. For that reasons, the goal of gamification — to invoke gameful experiences — is emphasized in their definition, in contrast to a focus on the application of methods (p.19). Gamification is thus:

> *“A process of enhancing a service with affordances for gameful experiences in order to support user’s overall value creation.”*

The proposed service marketing perspective is especially striking in terms of the notion of “*value creation*”. In service marketing, in contrast to traditional marketing, the customer or user of a product is thought of as a co-producer of the service in so far as the value is generated the moment a service or good is used (and not created in production and embedded in a product). Value is not objectively given but phenomenologically experienced (p. 18, VARGO/LUSCH 2008). As a consequence of this perspective, the value of a service — a game is conceptualized as a service system — is set only by the user, the game designer only makes value propositions: "A game emerges only when the use of the service results in a gameful experience" (p. 19). Further their definition entails that a specific core service is *enhanced* by an additional one.

CUNNINGHAM/ZICHERMANN (2011), define gamification from a marketing perspective (p. XIV) as:

> *"The process of game-thinking and game mechanics to engage users and solve problems"*

Notably this definition explicitly states the intended purpose of gamification: to increase engagement with a service. Furthermore, the authors emphasize the openness and the procedural character of gamification.

The common ties of the definitions given can be summarized as follows (this can also be read as a stipulative or working definition for the sake of this thesis): gamification intends to cause *gameful experiences* (gamefulness) of users through *enhancing* existing *services* with certain *game design elements* (design patterns, elements and mechanics). The experiential quality (gamefulness) is thought of as increasing the user engagement with the system (The theoretical underpinnings for this claim will be discussed in (Ch. 3.4).

However several points of contention remain regarding the given definitions: Arguably the definition of HUOTARI and HAMARI (2012) has two major drawbacks: First, their definition relies heavy on the notion of experiential qualities in general and that of "gamefulness" in particular. It is arguably problematic to try to reduce the notion of gaming to experiential qualities thus exposing the value of a service seemingly solely to subjectivity, especially may such a definition not be suitable for providing guidelines in enhancing an existing system with gamification. Furthermore, although it seems somewhat beneficial to stronger focus on user experiences of products instead of solely on design elements, a clear conceptualization of "gamefulness" or "gameful experience" is lacking, as the authors briefly admit (p. 19). Such a conceptualization would require them to define games themselves, a task leading inevitably to a tautology — one might add — if the notion of a game is to subjectively experience gamefulness (apart from the problematic existential claim of the uniqueness of "gameful experiences" per se). Secondly, the distinction between a core service and an enhancing service is also dependent on subjective judgment of the user of a service (p. 20). A similar problem arises regarding the definition of DETERDING et al. (2011): as the definition states, gamification uses *elements* of game design and not full-fledged games, although such a clear distinction between a game and an artifact with game elements is, as indicated by HUOTARI and HAMARI (2012), not possible, as the subjective experience plays a major rule in stating that something is a game or not. Not to mention social factors and their interrelation with the empirical and individual.

3.3 Related Concepts

3.3.1 Edutainment

The term “Edutainment” is composed of “education” and “entertainment”, which describes also its basic notion: to educate through entertainment — although the concept is not restricted to video games and encompasses different media such as television programs, video games, films, music, multimedia, websites and computer software (RAPEEPISARN et al. 2006). In terms of restriction to computer games (educational computer games) can the concept be seen either as a precursor (MA et al., p. 34) or an umbrella term for serious games, however the intention of serious games is not restricted to the purpose of education (see 3.3.2). The term differs in analogous manner from gamification.

3.3.2 Serious Games

As indicated above (see Ch. 3.2), the concept of serious games is highly interrelated with gamification. DETERDING et al. (2011, p. 11) argue that the main difference to serious games is the incorporation of game *elements* in contrast to using *full-fledged* games for non-entertainment purposes, although, at it was shown, this distinction is fuzzy. Nonetheless, a minor conceptual difference between “making a game of something that is not a game” (gamification) (DÖRNER et al. 2016, p. 6) and creating a game with an additional purpose in mind (serious game) can be insinuated, especially if the characteristic notion of enhancing an (existing) service for gamification is kept in mind. In this spirit DÖRNER et al. (2016, p. 3) (for a similar definition see also RITTERFELD et al. 2009, p. 6) define serious games:

> *“A serious game is a digital game created with the intention to entertain and to achieve at least one additional goal (e.g., learning or health). These additional goals are named characterizing goals.”*

The outlined characterizing goals can be used to differentiate serious games further: for example, the term “*exergames”* is used for games aiming to encourage people‘s healthy lifestyle and the term “*advergames”* for marketing purposes and recruiting (p. 4). Notably, other, more restricted or different definitions of serious games exist which for example either require serious games not to have fun as a primary purpose, or characterize serious games by the intention of the user and not of the developer (similar to the difference between DETERDING et al. (2011) and HUOTARI/HAMARI‘s (2012) definitions), or even demand that they are not played in a formal educational setting or are not restricted to *digital* games (p. 3).

3.3.3 Funology

Funology is a concept coined by human-computer interaction (HCI) research and is defined as “the science of enjoyable technology” (BLYTHE et al. 2004A, p. 36). In HCI this concept entails a shift from a usability approach, in which the center of attention was how good a service can perform a task for which it was originally designed — an arguably reductive view of humanness (BLYTHE et. al 2004b, p. XII) — to a broader perspective encompassing enjoyment (p. XVI). Funology, like the concept of serious games, draws from concepts of different areas like computer science, psychology, sociology, philosophy, literary and cultural studies.

3.3.4 Games with a Purpose (GWAP)

The basic idea behind the concept of “*games with a purpose”* (GWAP) is to use people to “solve large-scale computational problems” through (online) games (AHN 2006, p. 96). The concept can be characterized as a human-based computation technique. Humans are used for computational tasks that can not or not yet be automated. Applications range from classification (e.g. tagging of images) or collection of data to training of reasoning algorithms (AHN/DABBISH 2008). Similar to other discussed concepts, the rationale is that games are played for entertainment purposes, thus making repetitive or otherwise boring tasks fun or “game-like” engages user with a service or task. GWAP can be understood to be related to both gamification and serious games: the use of games (versus game-elements in gamification) for a *certain* non-game purpose (human-based computation for crowdsourcing or citizen science).

3.3.5 Summary and Outlook

Besides gamification there exist a bundle of similar concepts, out of which a few of the more prominent examples were discussed in this chapter. Although the central ideas behind these concepts — to engage users with tasks, systems, services or learning content with the help of affordances for entertaining or gameful experiences — seems to be the same, the specific goals and means to achieve these goals may differ. The common implications of the concepts discussed — including gamification — may they be implicitly or explicitly formulated, are that games or game-like systems are an effective tool for the motivation and engagement of users in non-entertainment contexts (SEABORN/FELS 2015, p. 14). In the following chapter the theories sustaining such a claim — focusing on gamification — will be discussed.

3.4 Theoretical Underpinnings

The concept of gamification draws heavily, regarding its intentions, from different other established theories, mainly from the social sciences. As there exist different gamification frameworks, the reference to theoretical underpinnings differ. In their survey on the theory and practice of gamification, SEABORN and FELS (2015, p. 20) identified as a similarity between different gamification frameworks the common reference to the interrelated concepts of motivation, engagement and behavior change.

The understanding of player motivation is argued to be of the highest importance for designing a gamified system (CUNNINGHAM/ZICHERMANN 2011, p. 15). Motivation can be described as drives, e.g. wants and needs, “that propel us in specific directions” (LILLIENFELD et al. 2015, p. 465) or a process, in which goal-directed activities are energized, directed and sustained (SCHUNK et al. 2008). The concepts of motivation and engagement are closely related and often used interchangeably, although engagement can be regarded more as “behavioral expression or manifestation of a motivated state” — the directional expression of motivation in contrast to its energy part (RIGBY 2014, p. 119).

The most commonly cited theory of motivation with respect to gamification is *Self-Determination Theory* (SDT) (DECI/RYAN 1985). In SDT, the most basic concerning different types of motivation is that between *intrinsic* motivation, i.e. “doing something because it is inherently interesting or enjoyable” (RYAN/DECI 2000a, p. 55) and *extrinsic* motivation, i.e. “doing something because it leads to a separable outcome” (ibid.), for example to get rewards. A central claim of SDT is that the quality of experience and performance differs depending on being motivated by extrinsic or intrinsic reasons (ibid.). Intrinsic motivation is thought of as being an important factor of physical, cognitive and social development, as acting on intrinsic interests is fundamental for increasing ones knowledge and skills (p. 56).

Although this basic distinction is not thought of as a dichotomy, as there are different levels of extrinsic motivation, varying on the degree of autonomy (p. 60) and even the general distinction itself was questioned (REISS 2004), it can be and was used to roughly classify psychological theories with respect to motivation (VASSILEVA 2012, RICHTER et al. 2015). One cluster of theories is related with external motivation, including such theories like reinforcement theory and expectancy theory. Another cluster of theories is concerned with internal motivation, encompassing theories like Maslow‘s hierarchy of needs, need achievement theory, goal setting theory and self-efficacy theory. Related to these two clusters are social motivators, expressed in theories like social comparison and personal investment theory. The already introduced SDT is thought of — alongside other theories like the theory of planned behavior (AJZEN 1991) — as a comprehensive theory, as it encompasses the whole spectrum of motivations.

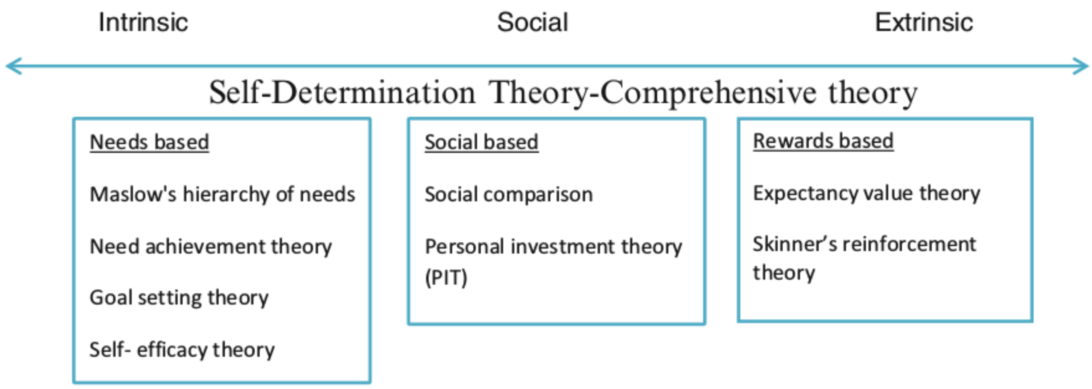

Fig. 1: Motivation theories in psychology (RICHTER et al. 2015, p. 24)

3.4.1 Self-Determination Theory (SDT)

On of the other main theoretical claims of SDT — besides the already mentioned theoretical distinction between intrinsic and extrinsic motivations and their different theoretical weighting — is, that people have three basic psychological needs, which are the basis for self motivation, mental health and personality integration (RYAN/DECI 2000b, p. 68): competence, autonomy and relatedness. It is argued that a feeling of *competence,* i.e. to aim for control and to experience mastery, can be induced by optimal challenges, effectance-promoting feedback and the absence of degrading evaluations (RYAN/DECI 2000a: 58). Although intrinsic motivation will not be enhanced if the feeling of competence is not accompanied by a sense of *autonomy,* i.e. to feel to be the cause of one's actions in life, to have a feeling of self-determination. Extrinsic rewards, or basically every tangible reward given with respect to one's performance on certain tasks, undermine intrinsic motivation. Additionally, threats, deadlines, directives or imposed goals reduce intrinsic motivation, as the perceived locus of causality is shifting toward the external. A sense of autonomy can be enhanced by giving opportunities of self-direction and acknowledgment of feelings (RYAN/DECI 2000b, p. 70). A feeling of *relatedness* — the need to interact and be connected to others — and security is thought of as making intrinsic motivation more likely (p. 71). Intrinsic motivation — arguably a major drawback for its fostering — is dependent on activities which are *perceived* as intrinsically interesting, activities that have "the appeal of novelty, challenge or aesthetic value" (p. 71), and therefore on individual and contextual factors.

Motivation for activities not subject of being perceived as intrinsically interesting can be understood as extrinsically motivational. Like indicated above, SDT argues that extrinsic motivation differs in terms of degree of autonomy. RYAN/DECI (2000a, p. 61) outline four categories of extrinsic motivation (sorted ascendant with respect to their degree of autonomy): *external regulation, introjection, identification and integration*. *External regulation* refers to behaviors striving to satisfy externals demands or obtaining externally imposed rewards, behavior is generally experienced as controlled or alienated, having an external locus of causality (p. 62). This type of external motivation corresponds to Skinner's operant conditioning theory. *Introjected regulation*, as a form of internal regulation, is behavior performed either with feelings of pressure or in order to enhance one's ego or pride. *Identification* refers to acting with respect to a believe in personal importance of a behavior, to take the regulation and make it one's own. *Integration* is a result of complete assimilation of identified regulations into one's self, in coherence with existing value and needs (ibid.). A crucial point with respect to gamification — as the intention behind the concept is to engage and motivate people to use a service which they currently do not use or not use intensively, i.e. not being intrinsically motivated to do so — is how to encourage autonomous regulation of extrinsically motivated behavior (see p. 64). The process of internalization is fostered through the same experiences characteristically accompanied by intrinsic motivation: relatedness, autonomy and competence.

In analogous manner to the motivational quality of experience, a distinction between the implicit structure of goals can be drawn. *Intrinsic goals* encompass affiliation (relatedness), community feeling (helpfulness), physical fitness (health) and self-acceptance (growth) as well as other goals in line with being "inherently valuable or satisfying to the individuals" in contrast to *extrinsic goals* like financial success (money), social recognition (fame) and an appealing appearance (image), which "primarily entail obtaining contingent approval and reward" (KASSER/RYAN 1996, p. 80). It was shown that greater well-being and sustained engagement correlate with having intrinsic goals (ibid.). For the motivational model of gamification these findings entail that the orientation towards intrinsic goals or the minimization of emphasis towards extrinsic goals leads arguably to higher chances for a gamified service to succeed in deepen long-term user engagement (RIGBY 2004, p. 130).

As (video) games are arguably played because "they are fun", and play seems to be always volitional (see Ch. 2.1), games can be described as ends in themselves, because "they tap into fundamental need-based motivational processes" (PRZYBYLSKI et al. 2010, p. 165). The experiences of autonomy, competence and relatedness are arguably major contributors to game experience and enjoyment (RICHTER et. al. 2015, p. 33, PRZYBYLSKI et al. 2010). This tight relationship is enabled in games through the support of *competence*, in the form of an appropriate level design, feedback mechanisms and balancing of player skill against game challenges, *autonomy*, by giving players options over different game elements, and *relatedness* through providing, for example, game communities or multi-player functionality (DÖRNER et al. 2016, p. 249, PRZYBYLSKI et al. 2010, p. 156). In contrast to real-world contexts, computer games do lack physical substrate, therefore *mastery of control*, i.e. the "learned ability to effortlessly perform intended actions in the game's virtual environment", is a necessary condition for motivation in games (PRZYBYLSKI et al. 2010, p. 156). Based on SDT, a model for understanding the motivation and enjoyment in games has been developed, the so-called PENS (player experience of need satisfaction) model (RIGBY 2004), which is in use in a wider array of empirical studies (RIGBY 2014, p. 122). A major finding of one of these studies (RIGBY 2012), with regard to SDT, was, that the satisfaction of the three basic psychological needs of competence, autonomy and relatedness predicted sustained engagement and motivation over a longer period of time (up to two years later) (RIGBY 2014, p. 122).

After giving a short overview of the most important comprehensive theory with respect to Gamification, a choice of theories concerned with each end of the spectrum is discussed in the following, starting with theories with respect to intrinsic motivation.

3.4.2 Maslow's Hierarchy of Needs

Acccording to MASLOW's theory of *hierarchy of needs* (1943), the satisfaction of primary needs like physiological needs and needs for safety and security is necessary in order to advance to more complex secondary needs like desires for belongingness, love and self-esteem, whereas self-actualization is thought of as being on top of the hierarchy (LILLIENFELD et al. 2015, p. 468). An adaption of MASLOW's theory is used to explain the basic needs of a player (SIANG et al. 2003: 244): on the bottom level the player is trying to understand the basic rules of the game (*rules need*). When this need is satisfied, the player seeks safety, i.e. to get information regarding on how to stay in the game and win the game (*safety need*). At the next level, belongingness, the player needs to have a feeling of comfort with respect to the game and feel that it is possible to win the game (*belongingness need*). After that it is necessary to feel good playing the game and get a feeling of control over the game (*esteem need*) before players need to understand and know more about the game in terms of strategy and hidden functions while expecting new challenges. It is only after these needs are fulfilled that players develop aesthetic needs in terms of good graphics, visual effects or sound (*aesthetic need*) and finally to be able to do anything that is possible within the rules of the games (*self-actualization need*). Although MASLOW's universal claim of an invariant hierarchy of needs is doubtable (LILLIENFELD et al. 2015, p. 468), it may serve as a good general design guideline as well as to help understand why certain games are, in general, more motivating than others, as these might fail to serve more basic (player) needs and focus too much on higher level needs, while motivating games succeed in serving all needs along the hierarchy.

3.4.3 Skinner's Reinforcement Theory

SKINNER's (1957) reinforcement theory is maybe the prime example of a theory concerned with explaining (externally regulated) extrinsic motivation. *Reinforcement,* as understood by SKINNER, refers to outcomes or consequences of a behavior that strengthen the probability of a behavior — behavior itself is thus the product of reinforcement (LILLIENFELD et al. 2015: 248). A basic distinction is that between *positive* reinforcement — i.e. to administer a stimulus — and *negative* reinforcement — i.e. to remove a stimulus —, in order strengthen the probability of a behavior. The counterpart of reinforcement is *punishment*, outcomes or consequences of a behavior weakening the probability of a behavior (ibid.). Reinforcement should be used over punishment, as punishment has a few disadvantages. A very important finding of SKINNER was that behaviors differ depending on the schedule of reinforcement — the deliver pattern of reinforcement: If a behavior is reinforced on every occurrence (*continuous reinforcement*), the behavior is learned more quickly but is faster extincted (extinction refers to the notion of gradual reduction and eventual elimination of a response), but if the behavior is only occasionally reinforced (*partial reinforcement*) the behavior shows greater resistance to extinction (p. 251).

More precisely, reinforcement schedules can be *fixed* (reinforcement occurs regularly) or *variable* (on an irregular basis) and work on *ratio* schedules (reinforcement is dependent on the number of responses) or *interval* schedules (dependent on the amount of time since the last reinforcement) (p. 252). Notably, variable schedules lead to more consistent responding rates than fixed schedules and ratio schedules show higher rates of responding than interval schedules. If these two dimension are combined, variable ratio schedules, i.e. providing reinforcement after a randomly varying average number of responses, yields the highest response rates. A typical example of this reinforcement schedules are slot machines (ibid.). With respect to gamification or games in general SKINNER's theory shows how people can get "hooked" on games: through carefully crafted reinforcement schedules, delivered in the form of feedback mechanisms or reward systems.

3.4.4 Flow

Crucial for the distinction between game and non-game contexts is that of game experience (DÖRNER et al. 2015, p. 11) or gamefulness (DETERDING et al. 2011, p. 11): the unique experiential quality of "true gaming". A major contributor to that experience is the so called *flow* or game flow experience, a concept standing a bit outside of the proposed mapping of motivation related theories to needs, rewards and social based theories proposed by VASSILEVA (2012) and RICHTER et al. (2015). Flow refers to an intrinsically motivated activity, a *subjective* state of optimal experience (NAKAMURA/ CSIKSZENTMIHALYI 2002, p. 89). This state has been described as consisting of eight components (CSIKSZENTMIHALYI 1990, p. 49):

1) confronting a task with the feeling, that it can be completed; 2) an ability to concentrate on the task; 3) and 4) the concentration is possible because the task has clear goals and provides immediate feedback; 5) an effortless but deep involvement, removing worries and frustrations regarding everyday life; 6) a sense of control over one's action; 7) the concern for the self disappears only to emerge stronger after the flow experience and 8) the sense of the duration of time is altered.

Important conditions regarding a flow state are that perceived challenges or opportunities for action stretch existing skills without exceeding them or under-utilizing them, and clear and proximal goals with immediate feedback about progress being made (NAKAMURA/ CSIKSZENTMIHALYI 2002, p. 90). It is hardly surprising — although flow being a universal experience — that early research focused on play and games (p. 89). The concept of flow was also applied more thoroughly to gaming to explain game experience (see SWEETSER/ WYETH 2005). The authors mapped game elements to elements of flow and provided assessment criteria for these elements.

Games Literature	Flow
The Game	A task that can be completed
Concentration	Ability to concentrate on the task
Challenge Player skills	Perceived skills should match challenges and both must exceed a certain treshold
Control	Allowed to exercise a sense of control over actions
Clear goals	The task has clear goals
Feedback	The task provides immediate feedback
Immersion	Deep but effortless involvement, reduced concern for self and sense of time
Social Interaction	n/a

Table 3: Mapping of game elements to elements of flow (SWEETSER/ WYETH 2005, p. 4)

3.4.5 (Situated) Motivational Affordances

Regarding the granularity of the introduced motivation theories, it seems that these models explain the universal motivational effect of games in general without taking into account specific game *elements* and their link to the level of interface or game design patterns, strikingly important for gamification (see DETERDING 2011, p. 2). A conceptual model for studying at this level was proposed by DETERDING (2011). It draws from the theory of motivational affordances. An *affordance* refers to “actionable properties between the world and an actor” (NORMAN 1999, p. 39). These relationships exist naturally, although from a designers point of view, perceived affordances, actions that the user only *perceives* to be possible, play a bigger role (ibid.). *Motivational* affordances are properties of an object in terms of how they can support the motivational needs of a user (ZHANG 2008, p. 145), whereas the motivational needs refer to the ones proposed by Self-Determination Theory (SDT). DETERDING (2011, p. 2) argues that both SDT research and the theory of motivational affordances are unaware of the context and social situation in which an interaction with an artifact takes places, which both determine the motivational power of game usage — e.g., the usage situation of voluntariness of play, fostering the experience of autonomy, and lack of consequence or extrinsic motivators. Furthermore, these motivational affordances, as properties of the artifact, are situated as well, in terms of being partially determined by their situational usage and meaning (p. 3). Although the artifact itself can determine the usage situation as well — through enabling or constraining possible uses —, therefore serving as an interactional focus or priming of associated cognitive schemata. Hence, the framing of a task as play or game can lead to a different perception of the situation. DETERDING (2011) is therefore able to explain, why the import of elements out of a game or play context into another usage context does not automatically entail to the same motivational affordances, as these have to be understood as *necessarily* situated (p. 3).

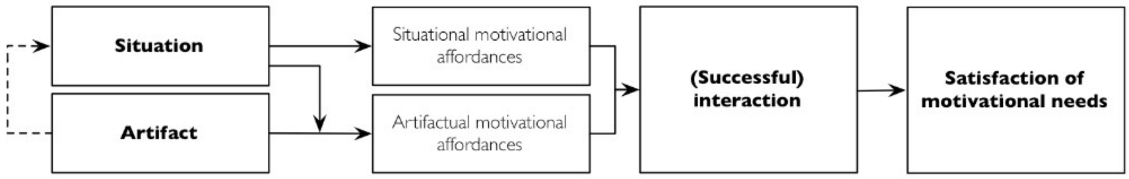

Fig. 2 Situated motivational affordances (DETERDING 2011, p. 3)

A mechanistic view of gamification regarding its motivation pull — i.e. to suggest that to transfer game elements in non-game contexts can be done without situational awareness — is thus plain wrong, as in addition to understand how and which game elements are motivating or provide motivational affordances, and how to successfully implement them in certain situations or contexts, the complex interrelation between the elements and the situation have to be taken into consideration.

3.4.6 Summary

To summarize, well-crafted games or gamified systems provide (motivational) affordances for game experience, as they tap into the basic psychological needs of competence, autonomy and relatedness. The fulfilling of these basic needs is claimed to be the foundation of long-term engagement and motivation. A major dimension of game experience can be described as being in a state of flow. Game flow as well as SDT provide concepts to measure the experiential quality of games. Operant conditioning or reinforcement theory explains — on a behavioral level — the effectiveness of affordances for extrinsic motivations. Successful and motivating gamification has to take the complex interrelation between the motivational affordances of artifacts and situations into account.

3.5 Game Design Elements

To leave the complex interrelation of game elements and situations — highlighted in the conceptual model of situated motivational affordances — behind, a selection of constituents of (artifactual) motivational affordances of games, or game design elements — from a designer's point of view — ranging from concrete to abstract, will be discussed in the following sections (see Table 2). The taxonomy proposed by DETERDING et al. (2011) has, besides its conceptual clarity, the advantage of being used in early attempts of formalizing the gamification design process using a domain-specific language (GaML — see HERZIG et al. 2013) in order to bridge the gap between domain experts or gamification designers and IT-experts. Notably, the distinction drawn between the different levels in the taxonomy can only be thought of as analytical, as many overlaps between different concepts exists. Furthermore, some game design elements situated on higher levels of abstraction regarding this taxonomy actually cover a wider range of these levels.

3.5.1 Game Interface Design Patterns

On the lowest level of abstraction, game interface design patterns are situated. Patterns are defined as "common, successful interaction design components and design solutions for a known problem in a context" (CRUMLISH/MALONE 2015, p.12). Like building blocks, these fundamental components of user experience, unaffiliated in terms of technical solutions or aesthetics, can be combined with other patterns and pieces of an interface in order to craft an interactive user experience (ibid.). Probably the most common cited game interface patterns are points, badges and leaderboards (see for example SEABORN/FELS 2015, CUNNINGHAM/ZICHERMAN 2011, CRUMLISH/MALONE 2015). Notably, these patterns are not necessary conditions for games and should be only thought of, at most, as characteristic to them (see DETERDING et al. 2011) or as starting point for gamifiying a system (WERBACH/HUNTER 2012, p. 72). On the contrary, gamified systems applying only or mostly these patterns have been subject of critique (see Ch. 3.8.2) in terms of undermining the full potential of gamification or being even harmful regarding certain goals wished to be accomplished by the gamified system.

Points are arguably central for any gamified sytem (CUNNINGHAM/ZICHERMANN 2011, p. 36). They may serve different purposes in the system ranging from representing players score and displaying progress/win states to providing instantaneous and easy feedback for the player as well as data for the game designer (WERBACH/HUNTER 2012, p. 73). Apart from that, points are either rewards themselves or are tied to tangible prizes. Points can be further differentiated due to the purposes they serve in the gamified system in experience points, redeemable points, skill points, reputation points and karma points (CUNNINGHAM/ZICHERMANN 2011, p. 40).

Badges are "visual representations of achievements" within gamified systems (WERBACH/HUNTER 2012, p. 74). They are often tied to certain levels of points or the fulfillment of certain tasks within the gamified system (ibid.) and serve different individual and social functions (ANTIN/CHURCHILL 2011, p. 2f): Badges can act as a motivating goal-setting device as users are challenged to meet a certain mark set by the designer. They may act not only as an instruction on what activities are possible within the gamified systems — an important aspect of "onboarding" or engaging (new) users (WERBACH/HUNTER 2012, p. 75), but also show which activities are valued in the community or system. Conversely, badges shows other users or the game designer in which activities a user was engaged, thus providing clues about her skill-set, level of engagement and expertise. Badges work therefore as status symbols as they "show-off" achievements and accomplishments, not only possibly influencing how the user is perceived by others but also providing personal affirmation in terms of reminding the user of his or her past achievements and successes. Badges can foster group identification as users may perceive similarity between themselves and other group members (ANTIN/CHURCHILL 2011, p. 3).

Leaderboards are ranking systems that allow comparisons between players (CUNNINGHAM/ZICHERMANN 2011, p. 50). The leaderboard is usually an ordered list, ranking users by score from highest to lowest (CRUMLISH/MALONE 2015, p. 212). It is arguably useful to provide different views of a leaderboard (e.g. all-time standings, weekly and daily standings), offer abilities to filter (e.g. for friends or on a local level) (p. 213) and to measure different attributes emphasized by the respective designer (WERBACH/HUNTER 2012, p. 77). The nature of the activity or community has to be taken into consideration, as leaderboards are arguably competitive in nature (CRUMLISH/ MALONE 2015, p.212). If there exists no simple correlation between measurability and quality like in competitive contexts, leaderboards are promoting activities which may undermine the designers intention (p. 214) or even influence the community dynamic altogether — possibly up to a point, that members question each other's motivation for acting) (p. 216). The use of leaderboards has therefore mixed motivational effects: On one hand they are considered to be effective motivators using social pressure to increase users engagement, possibly leading to positive effects on participation and learning (SAILER et al. 2017, p. 373) but can also be regarded as having negative effects on motivation as users ranked on the bottom may stop acting all together if the gap between them and the top users are perceived as too big to bridge (WERBACH/HUNTER 2012, p. 76).

WERBACH/HUNTER (2012, p. 80) mention, alongside the already described ones, other components — “more-specific forms that mechanics or dynamics can take” (see Table 4).

Component	**Description**
Avatars	visual representations of a player and/or his character, used for identification in its double meaning (identification of the player *amongst* others and identification of the player *with* its avatar or community)
Levels	indicators or progression of a player in the system
Quests	predefined challenges with objectives and rewards
Combat	a defined battle, typically short-lived
Content Unlocking	aspects available only when players reach objectives
Gifting	opportunities to share resources with others
Boss Fights	especially hard challenges at the culmination of a level
Collections	sets of items or badges to accumulate
Virtual Goods	game assets with perceived or real-money Value
Teams	defined groups of players working together for a common goal
Social Graphs	representation of players’ social network within the game

Table 4: Game components as presented in WERBACH/HUNTER 2012, p. 80

3.5.2 Game Design Patterns and Mechanics

Game design patterns — like interface design patterns (see Ch. 3.5.1) — refer to the concept of pattern language (ALEXANDER 1977), but instead of using prototypical implemented solutions like the latter, they — like game mechanics — can be implemented with different interface elements (DETERDING et al. 2011, p. 12). However, there exists some overlapping in the concepts especially with respect to WERBACH/HUNTER's (2012) so-called "components".

BJÖRK/HOLOPAINEN (2005, p. 34) define game design patterns as:

> *"Semi-formal interdependent descriptions of commonly reoccurring parts of the design of a game that concern gameplay."*

Notably, the authors do not use quantitative measures regarding gameplay. This is due to impractical restraints on the design process strict measures would impose. The presence or effect of certain patterns is therefore not accurately measurable and an automatic use is impossible (p. 35). Nonetheless, the structure of and relationships between patterns can be described and patterns are therefore distinguishable entities. With each pattern a part of a possible interaction in a game is describable, all patterns used in a game combined, describe thus the possible gameplay in a game (p. 4). Game design patterns are not only useful in analyzing games but also in the design process itself (ibid.). The original inventory presented by BJÖRK/HOLOPAINEN (2005) consists of over 200 interrelated patterns divided into 11 different categories, which in term can be further reduced to 4 components: Game design patterns that focus on the structural part of games, their elements and how these elements are "produced and consumed during gameplay and on what information exists about them" (p. 54) (game design patterns for game elements, resource and resource management, and information, communication and presentation). Secondly, patterns dealing with temporal aspects (actions and events patterns, patterns for narrative structure, predictability and immersion). Following patterns regarding boundaries in games (patterns for goals and goal structures) as well as patterns relating to how games interact with other games or activities (patterns for game sessions, game mastery and balancing and meta games, replayability and learning curves) (ibid.). Besides this inventory of patterns, different lists regarding different types of games, e.g. location-based games (SINTORIS 2015) or games played on mobile devices (DAVIDSSON et al. 2004), exist.

As to be expected, an array of different definitions of *game mechanics* exist with varying degree of abstractness. Notably though, in gamification literature game mechanics are often mixed up with game interface design patterns or components. CUNNINGHAM/ZICHERMANN (2012, p. 36) are explicitly referring to points, badges and leaderboards as "game mechanics", a fact game designer and theoriest BOGOST (2011b, p. 4) criticizes heavily, as these "mechanics" should only be seen as contingent materializations or tools of game mechanics:

> *"[…] key game mechanics are the operational parts of games that produce an experience of interest, enlightenment, terror, fascination, hope, or any number of other sensations. Points and levels and the like are mere gestures that provide structure and measure progress within such a system."*

HUNICKE et al. (2004, p. 3) define game mechanics dual as *"particular components of the game, at the level of data representation and algorithms"* as well as:

> *"[…] the various actions, behaviors and control mechanisms afforded to the player within a game context. Together with the game's content (level, assets and so on) the mechanics support overall gameplay dynamics."*

The definition allows focusing on the relationship between "the formal, algorithmic elements of games and how they are presented and manipulated by the users" (SICART 2008). The authors use the example of card games to illustrate their definition: in card games, the mechanics would be for example shuffling, trick-taking and betting. Out of these mechanics specific dynamics may emerge, for example bluffing (p. 4).

SICART (2008) defines game mechanics as "methods invoked by agents, designed for interaction with the game state". This definition borrows its terminology from the object oriented programming paradigm: methods are "actions or behaviors available to a class" they are "mechanisms an object has for accessing data within another object" (ibid.). A game mechanic is therefore "the action invoked by an agent to interact with the game world, as constrained by the game rules" (ibid.). The game mechanics are used by the agent, which has not to be a human, but can be part of the computer system (e.g. AI agents), to interact with the game, which in term alters the game state. Game mechanics are "often, but not necessarily designed to overcome challenges, looking for specific transitions of the game state", thus reminiscent of a definition of games already encountered as "systems with mechanics, rules and challenges" (ibid.). SICART (2008) proposes similar to HUNICKE (2004), in order to understand game mechanics, to formalize them as verbs in combination with other structural elements like rules: e.g. ride (the horse), stab, jump, shoot (arrows) (ibid.).

Game Designer and academic SCHELL (2015, p. 158) argues that game mechanics are the "skeleton" of a game, "the interactions and relationships that remain when all the aesthetics, technology and story are stripped away", thus emphasizing a broader meaning of game mechanics encompassing not just the rules of interaction but the objects and content as well. Aware of the problems regarding the attempt to give a formal definition and an exhaustive analytical taxonomy (e.g., incompleteness, simplification, state of games as mental models and thus subjective), SCHELL (2015) proposes seven main preliminary categories useful for designing a game: Space, Time, Objects, Attributes and States, Actions, Rules, Skill and Chance (see Table 5). For WERBACH/HUNTER (2012, p. 79) mechanics are "the basic processes that drive the action forward and generate player engagement" encompassing ten important game mechanics: Challenges, Change, Competition, Cooperation, Feedback, Resource Acquisition, Rewards, Transactions, Turns and Win States.

Game Mechanic	Description	Example(s)
Space	Place where the game "takes place"; Places and their interrelated connections within the game; abstract mathematical constructs, describable regarding their dimensionality, connectivity, being discrete, continuous or nested	Chessboard (discrete 2D Space), Pool Table (~ continuous 2D Space)
Time	How Time is represented (discrete or continuous, nested) and controlled (absolute or relative time limits, pause or rewind or speed-up functionality) in the game	*Turns* in monopoly (discrete time), *Clock* for level in Super Mario (time constraint), *Races* (relative time limits), *Checkpoints* in Super Mario (rewind time)
Objects, Attributes and States	*Objects*, "everything that can be seen or manipulated" (e.g. Characters, props, tokens, scoreboards, space itself), possess *attributes*, i.e. information about an object, which have current *states* (static or dynamic*);* programmatically implementable via state machines	Each property on a Monopoly board can be considered an object with a dynamic attribute (among others) "number of houses" with states corresponding to the numbers of houses placed on it
Actions	Actions define what players "can do" in the game, how to interact with the objects; basic actions vs. strategic actions (how basic actions are used to achieve a goal = subjective measure)	Basic Actions in Checkers (among others): Move a checker forward, jump on an opponent's checker. Strategic Actions in Checkers (among others): Sacrifice a checker to trick, force an opponent into making an unwanted jump, …
Rules	most fundamental mechanic, defines space, timing, objects, actions, the consequences of actions, constraints on actions and goals; different rules can apply at different parts of play (modes); the most important rule is the definition and clear communication of game goal(s)	/
Skill	Skills a game requires from the player	Physical Skills, Mental Skills, Social Skills
Chance	Essential part of game fun (element of surprise and risk-taking); concerns interactions between all other mechanics	/

Table 5: Game mechanics as presented in SCHELL (2015)

Game design patterns and game mechanics seem to be overlapping concepts with a strong focus on (game) interaction design. Both game design patterns, as presented in BJÖRK/HOLOPAINEN (2005), as well as the different definitions (except maybe SHELL 2015), seem to cover the whole spectrum ranging from abstract to concrete patterns or mechanics. Although, the concept of game design patterns has the advantages of being able to model the relationships between different patterns as well as using the established concept of design patterns.

3.5.3 Game Design Principles and Heuristics

Game design heuristics are basically guide-line based methods for evaluating usability. In contrast to more expensive and time-intensive methods, heuristic evaluation can be used to find usability problems quickly and cheaply (SCHAFFER 2008, p. 79), although some degree of "thoroughness and certainty" is lost (p. 80). It is advised to use heuristics very early and iteratively in the design process to outline possible problems (p. 84). The concept was introduced by NIELSEN/MOLICH (1990) and originally focused on interface usability. Recently the concept has also been used to evaluate game design and aid in the game design process (p. 81). The basic process of one iteration of a heuristic evaluation can be outlined in the following steps (SCHAFFER 2008, p. 86):

1. *Designate 3-5 evaluators (novices or usability experts)*
2. *Choose a list of Heuristics (e.g., LAITINEN (2008))*
3. *Evaluators separately analyze the game using the heuristics, taking each heuristic on at a time*
4. *Problems found are compiled from the original lists, organized and delivered as a report*
5. *The designer fixes the problems in the respective area*

LAITINEN (2008, pp. 105-108) proposes a checklist to evaluate gameplay, including items like "The game provides clear goals or supports player-created goals", "The player is rewarded and rewards are meaningful" and "The player is in control". Notably, heuristic evaluation should be combined with user testing (SCHAFFER 2008, p. 86) (see Playtesting in Ch. 3.5.5).

3.5.4 Game Models

On a higher level of abstraction, game models — "conceptual models of the components of games or game experience" (DETERDING et al 2011, p. 12) — are situated. In this section the MDA model, a manageable and popular game model, is introduced.

The *Mechanics, Dynamics and Aesthetics (MDA)* model (HUNICKE et al. 2004), as its name suggests, is formed out of three interrelated concepts. It is basically a formal model allowing to bridge the gap between game designers and end users in understanding and designing games. G*ame mechanics* (already discussed in Ch 3.5.2) give rise to certain game dynamics (p. 4). *Game dynamics* describe "the run-time behavior of the mechanics acting on player inputs and each others outputs over time" (p. 2), they create aesthetic experiences. *Game aesthetics* can be understood as "the desirable emotional responses in the player, when she interacts with the game system" (p. 2). These emotional responses can be subsumed in the non-exhaustive categories of sensation (game as sense-pleasure), fantasy (make-believe), narrative (drama), challenge (obstacle course), fellowship (social framework), discovery (uncharted territory), expression (self-discovery) and submission (pastime) (ibid.). The aesthetics of a game can therefore be conceptualized as bundle of aesthetic responses it gives rise to. For example, the game of charades consists of the aesthetic components of fellowship, expression and challenge (in that order) (p. 2). From a dynamics point of view, certain aesthetic experiences like challenge can be created trough dynamics like time pressure and opponent play (p. 3).

The main point of the MDA model is that it is necessary, in order to create a good game, to consider both the perspective of the designer and the user, as well as the relationship between these three concepts. From the perspective of the designer the mechanics give rise to certain game dynamics, leading ultimately to certain aesthetic experiences, but from a user's perspective this relationship is turned around: the aesthetic experience is central (p. 2.). A small change in one layer leads to changes in the others. Changing aesthetic requirements will ultimately lead to changes in the game dynamics and mechanics. Changes in the game mechanics will lead to different game dynamics and aesthetics. The moving between these levels in an iterative design process helps to control for undesired outcomes and tune for desired behavior (p. 5).

3.5.5 Game Design Methods

Game design methods deal with "game design-specific practices and processes" (DETERDING et al 2011, p. 12). In the following the *playcentric design process* as presented in FULLERTON (2014, p. 15-20) is introduced. This specific design method due to its seven step structure has the advantage of being comprehensible and useful for the design process as well as serving as an example for a wider range of methods. Playtesting, included in many of the outlined steps, will be discussed in further detail at the end of this section, as it is of striking importance for every game design process and part of most comprehensive design methods (e.g. SCHELL 2015, BRATHWAITE/SCHREIBER 2009, WERBACH/HUNTER 2012).

1. *Brainstorming*: First, the designer sets player experience goals (FULLERTON 2014, p. 15). In contrast to game features, these goals are the experiences the designer aims for the players to have during the game. They can be formulated as descriptions of situations, for example. "players will have to cooperate to win, but the game will be structured so they can never trust each other" (p. 12). After setting experience goals, game concepts or mechanics achieving these goals are chosen, envisaged and narrowed down (p. 15). Useful for this step are for example the game design patterns from BJÖRK/HOLOPAINEN (2005) (see Ch. 3.5.2). Out of each of these ideas, a description or concept document is created. These written concepts are tested with potential players, possibly with the help of visual mock-ups (p. 16).

2. *Physical Prototype*: Out of pen and paper or other (craft) material a playable prototype is created. This prototype gets submitted to playtesting. If the playtest is successful — in terms of achieving the set player experience goals — a gameplay treatment describing how the game functions is written (three to six pages) (p. 16). Prototyping is used to test the fundamental mechanics of a game. A physical prototype has the advantage of being easily adoptable, even during playtesting, and allowing non-programming-experts to participate in the design process (p. 198). Alternatively or complementary, game design heuristics could be used (see Ch. 3.5.3).

3. *Presentation*: An optional step in the process if funding (e.g., for hiring of a prototyping team) is required. The presentation should include demo artwork and the gameplay treatment of step 2 (p. 16).

4. *Software Prototype(s)*: Crude digital models of the core gameplay are created. Playtesting of the software prototypes and if the gameplay works and the set player experience goals are met, the full feature set and all levels of the game can be developed (p. 15). Software Prototypes are useful for testing unanswered questions of the design, usually with incomplete gameplay, minimal art and sound. Software prototypes can be further differentiated into four areas: game mechanics, aesthetics, kinaesthetics and technology (p. 235). Prototyping *mechanics* should start with particular questions regarding certain mechanics leading to successive integration of more features (p. 236). Prototyping of *aesthetics* should answer questions regarding visual and aural dramatic elements of the game and their interrelation with mechanics. Helpful tools within this context are storyboards, concept art, animatics (animated mock-ups of the game in action), interface prototypes and audio sketches (p. 238). Prototyping of *kinesthetics*, the "feel" of the game for example in terms of controls or interface responsiveness has to be tested with a digital prototype (p. 239). Technology prototypes encompass models of all software needed for a working game (e.g. prototypes of graphics capabilities, AI systems or physics) in terms of "testing and debugging the tools and the workflow for getting content into the game" (p. 241).

5. *Design Documentation*: Notes and ideas for the actual game, possibly collected at earlier stages of the design process, are now put together during the creation of a document in the form of a list of goals for the game. This design document, not necessarily in static form, should be used as a collaboration and communication tool during the process (p. 16).

6. *Production*: In the actual production phase the goals defined in the design documentation are worked through. Evaluation regarding achieving experience goals and testing of artwork, gameplay and characters should be done in iterative circles with problems and changes becoming smaller each iteration (p. 20).

7. *Quality Assurance*: Quality assurance testing is conducted. For this step, only minor problems regarding gameplay and usability should exist (p. 20).

Playtesting, present in almost every of these steps, is fundamental in the design process. The basic idea is to get useful feedback from players along the game design process to improve the overall experience of the game (p. 271). In an iterative process of playtesting, evaluating the results and revising the game leads, ideally, to smaller changes and design issues (p. 271). Depending on the stage of the design process, different types of playtesters are suggested to be involved: in the early stages of foundation and basic structure development selftesting and playtesting with confidants is advised, whereas in later stages, where formal details are eloborated and the game is refined playtesting with a target audience is suggested (p. 275).

3.6 Empirical Evaluation and Findings

In this section major empirical findings regarding gamification are presented. Apart from a few major literature reviews on the effects of gamification in general (e.g. SEABORN/FELS 2015, HAMARI et al. 2014) a dozen of literature reviews on certain application contexts like fitness, education, marketing, work and data gathering, as well as studies with focus on certain game elements have been published (e.g. SAILER et al. 2017/ HAMARI 2017). Meta-studies, in the narrower sense of the word, have not been published, as research methodologies and theoretical groundings vary greatly (see also HAMARI et al. 2014, p. 3030).

The major literature reviews show in general “positive effects and benefits” (HAMARI et al. 2014, p. 3028) and a “positive-leaning but mixed picture” (SEABORN/FELS 2015, p.28) of gamification’s powers. Although, both studies conclude that the context of implementation as well as characteristics of the user play a big role regarding the effectiveness of gamification. Regarding the *context* of implementation it was found that similar implementations of gamification in different field of applications show different results (SEABORN/FELS, p. 28). Contextual factors like the general quality of a system in terms of which outcomes it produces and which kind of user behavior it generally affords, the surrounding social environment, as well as the quality of user involvement with a system (cognitive vs. affective) influence the effectiveness of gamification massively (HAMARI et al. 2014, 3030). *User characteristics* like age or familiarity with gaming as well as certain behavioral patterns expressed as “player types” influence both the effectiveness of the gamified system as a whole as well as inducing varying experience on the level of certain game elements or basic motivational affordances (ibid.).

3.7 Gamification Frameworks and Implementation

After discussing game design elements on different levels of abstraction, a closer look on gamification-specific frameworks as well as the implementation process of gamification into existing systems is taken.

In contrast to a full-fledged game — however problematic such a term may be — gamification selectively uses game design elements or methods to meet other objectives, mainly to motivate users to engage with a service and positively influence their behavior (or at least raise awareness for a service). Therefore, it is necessary to provide theoretical underpinnings for using certain game design elements like interface design patterns or game mechanics. Existing gamification frameworks provide a wide array of theoretical backgrounds and different ways to address these theories. As basic theoretical underpinnings have already been discussed in Ch. 3.4, this section will focus on the main direction and on the specific ways the respective frameworks address these theories in order to analyze and/or design a gamified service or product.

In his "*User-Centered Theoretical Framework for Meaningful Gamification*" NICHOLSON (2012) proposes an approach to gamification that focuses on intrinsic motivation rather than extrinsic rewards. Game-based elements should be meaningful and relevant to the user (p. 2), thus it is of the greatest importance for the user to be in the center of the gamification design process, to know what goals are relevant to her background, interests and needs (ibid.) but also to take the organizational context of the activity being gamified into consideration (p. 3).

SAKAMOTO et al. (2012) propose a *value-based gamification framework* to enhance intrinsic motivation of users. The basic notion behind the framework is that intrinsic motivation is increased when users perceive goods or figures used in activities as valuable (p. 421). The framework argues for five values used as design tools to develop gamification services. These values are grounded in the transtheoretical model of behavior change (p. 422): *Informative value* (sufficient information to support decision-making), *empathetic value* (providing virtual characters and social engagement), *persuasive value* (feedback with respect to current user situation as well as outlook on future effect of user activities), *economic value* (sense of ownership and collection) and i*deological value* (implicitly expressed abstract concepts like friendship and justice).

For BLOHM/LEIMEISTER (2013) gamification consists out of the design of gamified service bundles put together out of a core offer — a product, service or information system, and an IT-based gamified enhancing service for the core offer (p. 276). From the core offer specific usage objectives can be derived — e.g., through analyzing historic user behavior — which are subsequently translated into game-design elements that are compiled into gamified enhancing services. The authors stress, like NICHOLSON (2012), the importance of individual user motives in the design process (p. 276).

Whereas the frameworks of NICHOLSON (2012) and SAKAMOTO et al. (2012) address issues concerning the gamification design process, BLOHM/LEIMEISTER (2013) focus on the overall gamification ecosystem with its relationship to a core service or offer, a perspective which is now elaborated further. HERZIG et al. (2015, p. 435-437) understand the gamification development process as a general software development process. As such it can be differentiated into workflows consisting of different tasks (and roles) (see Fig. 3):

- *Business Modeling*: Identification of general objectives of the project and communication of the goal of the project to all project members (p. 433).

- *Requirements*: Analyze use cases based on project goals. Analyze end users regarding motivation, engagement and participation within the target processes to be gamified. Definition of target situation and metrics (e.g., engagement criteria) to measure the projects' success (p. 434).

- *Design*: Specification of a gamification design and its refinement in many iterations as in traditional game design (including prototype development and playtesting) (see Ch. 3.5.5) (p. 434-35).

- *Provisioning*: Selection of appropriate gamification solution with respect to certain technical constraints regarding the IT-infrastructure as well as the proposed gamification concept. Provisioning of all systems that need integration as well as their documentation, APIs and tools. If no existing gamification solution is appropriate, a custom implementation has to be developed. (p. 435)

- *Implementation*: Assemblage, integration and implementation of all components for the final gamified application. Depending on whether a gamification solution is used or an own solution is developed, the gamification concept has to be either integrated into the company's information system (IS) and configured within the target gamification solution or within the existing IS or as independent part (possibly using or developing additional services or custom user interfaces) (p. 436).

- *Test*: Testing of requirements and assumptions against the running prototype (ibid.).

- *Deployment*: Final deployment and open access to end users (ibid.).

- *Monitoring*: Assemblage and aggregation of operational user data in accordance with the chosen engagement criteria and process models. Modifications and suggestions for improvement of the gamification design, the engagement delta, are derived and communicated back (ibid.).

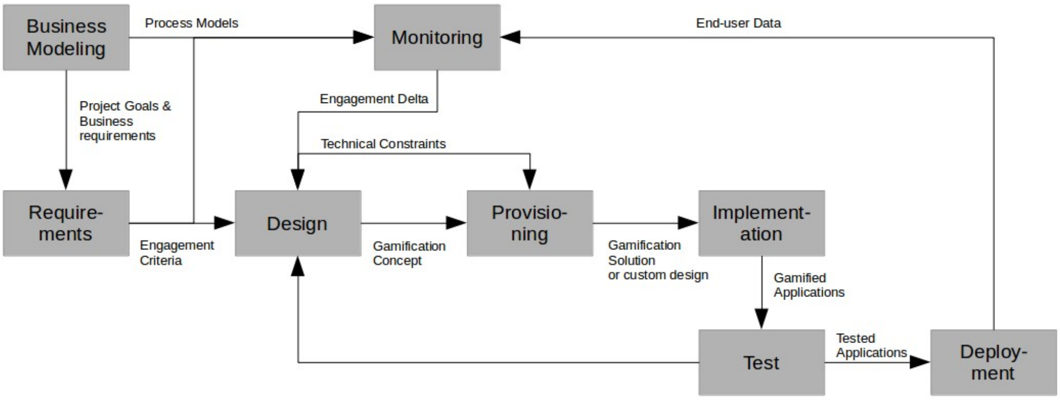

Fig. 3: Gamification development process (simplified after: HERZIG et al. 2015, p. 433)

3.8 Problems, Restrictions and Critique

3.8.1 Gamification as Bullshit, Exploitationware and Pointsification

In his critiques on the concept of gamification BOGOST (2011a, 2011b), academic and game developer, unfolds certain lines of argumentation, leading to the following two claims: 1. Gamification is "*bullshit"*. 2. Gamification should be termed "*exploitationware"* to better address its true meaning and secret intentions.

Loosely referring to FRANKFURTS's treatise "*On Bullshit"* (2005), BOGOST (2011a) argues that Gamification is "marketing bullshit", taking the powerful and "magical" medium games and "makes them accessible in the context of contemporary business". The term gamification, especially its suffix "-ify", implies that any medium could be easily and successfully "gamified" (2011b) solely through the implementation of "game mechanics" like points, levels, leaderboards and badges (e.g., CUNNINGHAM/ZICHERMANN 2011). Ultimately, to create "monetizable APIs and one-size-fits-all consulting workshops" (BOGOST 2011b). An approach that has also been termed "*pointsification"* by game designer ROBERTSON (2010):

> *"What we're currently terming gamification is in fact the process of taking the thing that is least essential to games and representing it as the core of the experience. Points and badges have no closer a relationship to games than they do to websites and fitness apps and loyalty cards."*

In the term "pointsification" the reductionist view on games expressed in gamification is perpetuated: Games are difficult to create and as complex systems not easily implementable into existing business operations — making even a change in its structures necessary, as they are undermining "many of the practices of industrialization" (BOGOST 2011a, 2011b). Furthermore, for the common practice in gamified systems is to replace real incentives like money with fictional ones like badges or points, thus undermining the relationship between customer and company in terms of both value and trust, gamification should be renamed as "*exploitationware",* to better illustrate such practice.

3.8.2 Reward-based Gamification or BLAP-Gamification

In similar fashion, but more concerned with the actual power of Gamification to engage and change users behavior, a specific type of gamification, focusing on rewards, has been subject of critique. Reward-based gamification or BLAP-Gamification can be characterized as an approach of providing external rewards through implementation of Badges, Levels/Leaderboards, Achievements and Points to real-world settings (NICHOLSON 2015, p. 2) — these terms have therefore strong similarities with ROBERTSON's (2010) "*pointsification*". Main point of contention is that, although giving users rewards can get them to engage with a system, these changes in behavior are usually only short-time and are likely to cease if the rewards end, especially it the user has no other reasons for engaging with a service (p. 1) or was not able to internalize the desired behavior (NICHOLSON 2012, p.2). Furthermore, reward-based gamification can even be harmful in terms of changing behavior in the long-term, as extrinsic rewards can undermine intrinsic motivation (see Ch. 3.4.1) (NICHOLSON 2015, p. 3). That is especially the case, if a reward-based system, built on an activity which people were already intrinsically motivated to do, is removed, leading to a smaller likelihood of engaging in an activity than before (p. 3). Although, if there was no intrinsic motivation to engage in an activity to begin with, and a skill with real-world value is to be learned — the skill is mastered and can be perceived as having real-world value, thus leading to its use without external rewards — the application of reward-based Gamification can be suitable (p. 2-4). Gamification strategies based on external rewards may even implemented in a way that sustains engagements and emphasizing long term behavior change if rewards are provided for engaging (and not performance), if rewards provide a natural enhancement of deeper engagement with the system and if rewards come unexpected (RIGBY 2014, p. 124). The basic idea is to use external rewards in a way that they are not perceived as controlling or manipulative and reinforce intrinsic value of behaviors (ibid.).

3.8.3 Lack of empirical Evidence — Gamification as Hype

There is some evidence suggesting that gamification can have positive effects on users (see Ch. 3.6), although it was pointed out in a major literature reviews that a "lack of statistical treatment of empirical data" on the evaluated studies leads to an absence of standard statistical measures of the size of the effect of gamification on the respective system (SEABORN/FELS 2015, p. 28). Furthermore, a lack of longitudinal and comparative studies make it hard to argue for long-term effects or to even isolate the effect of gamification (p. 29), which even may be caused by a novelty effect (p. 28 / HAMARI et al. 2014, p. 3028). Another point of critique is the lack of “well-established theoretical frameworks or unified discourses” (HAMARI et al. 2014, p. 3030) leading, together with a shortcoming of applied research to ground in theory or gamification frameworks, to a “major gap between theory and practice in gamification research” (SEABORN/FELS 2015, p. 28).

Apart from problems regarding empirical evidence and differing theoretical backgrounds, gamification is accused of being “driven by novelty and hype” as the technology consultancy GARTNER (2012a) puts it. They projected, that by 2014, 80 percent of current gamified applications will fail to meet their respective business objectives. Whereas poor game design, that is the focus on “obvious game mechanics, such as points badges and leader boards”, are regarded main causes (ibid.). In their so-called hype cycle model, where a technology’s life cycle is differentiated into five phases (GARTNER 2018a), gamification was put in the “peak of inflated expectations” in 2012, with the expectation of reaching the “plateau of productivity” in five to 10 years (GARTNER 2012b). In the 2014 hype cycle for emerging technologies it was put into the “through of disillusionment” but taken out since 2015, begging the question if gamification has outlived itself or is still stuck in the “through of disillusionment” with methodologies and best practices still developing.

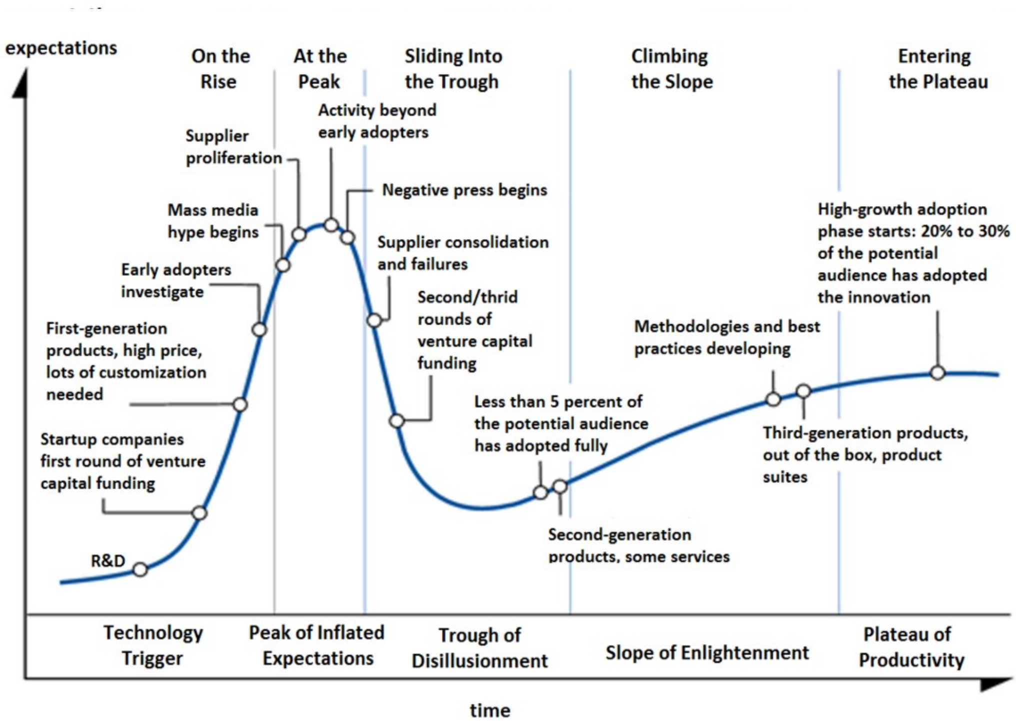

*Illustration 1: Hype Cycle Model (Source: Olga Tarkovskiy/*CC-BY-SA-3.0)

In the following section I would like to cast some further light on the points of critique raised from various sources regarding the theory and practice of gamification. I will provide some possible answers as well as possible restrictions on using gamification as a viable design approach, thus attempting to answer parts of the first research question raised in this thesis.

3.8.4 Gamification as viable Design Strategy?

It seems that early critique of gamification as a concept, propounded by game designers like BOGOST (2011a, 2011b) and ROBERTSON (2010), tackled a very reductive view of the concept per se or specific practices in the industry, utilizing only an “pointsified” thus “skinnerian” and marketing-oriented approach. This totally legitimate critique was perpetuated in different terms by (among others) NICHOLSON (2012, 2015) and SAKATMOTO et al. (2012), denouncing types of gamification that base solely on external rewards. A renewed approach to gamification not prone to the “pointsification-fallacy” and informed by psychological theory, thus focusing stronger on affordances for intrinsic motivation (e.g. NICHOLSON 2015 with “meaningful gamification”) might be possible directions to overcome problems arising with the utilization of a reductive view on gamification.

This reductive view of early gamification was perpetuated in early applications utilizing gamification, as designers were, if referring to theory at all (see SEABORN/FELS 2015), explicitly referring to works like CUNNINGHAM/ZICHERMANN (2011), which consequently led to bias problems regarding empirical evaluation, as mainly certain game elements like points, badges or leaderboards — a reduced sample — was considered in testing. On a more thorough level of critique, the methodology of most tests, i.e. to isolate and test certain game design elements, either through manipulation independent of one another or against non-gamified applications attempting to derive universal quantifications on the effectiveness of certain game elements, thus the mere surface structure of the game layers and not the mechanics or rules that govern these elements are taken into consideration, could be raised to question (e.g. see SAILER et al. 2017, p. 373 or SEABORN/FELS 2015).

The basic theoretical construct behind most theoretical gamification frameworks is SDT. Disparate referring and mapping of game elements to corresponding elements of SDT (competence, autonomy or relatedness) (e.g., SAKAMOTO et al. 2012) seems simplistic or mechanistic as game experience arises out of a complex interrelation of game design elements (components, mechanics, contexts and users themselves). As game designers point out (e.g., SCHELL 2015, FULLERTON 2015), game design is not an easy a task as proponents of early gamification would argue. The lack of proper game design skills and the utilization of game design theory or practices is therefore among the key reasons for gamified applications to fail (GARTNER 2012b), hence the importance of a strong focus on game design elements as well as the theory behind gamification.

Before arguing why gamification can be a viable design solution and thus be applicable to geospatial applications in the broadest sense, a restriction with wide-ranging consequences has to be addressed: Gamification, contrary to popular belief or connotations regarding its word formation, is not a *method* but a *design strategy*. As the analysis of gamification literature showed, designers can only aim to provide (motivational) *affordances* for gameful experiences (see HUOTARI/HAMARI 2012), something that can always fail — not only due to inherent conceptual features of gamification (e.g., arguably, games require volitional participation), but also due to the non-controllability of the usage situation, as well as the importance of context (see DETERDING 2011), personal factors (see RYAN/DECI 2000a, 2000b) or the effect or power of framing something as game(-ful) altogether (BOGOST 2011a, 2011b). Thus, the notion of systematization of a unified gamification method or technique, expressed in an "optimal combination of game elements, mechanics, and dynamics that always works" (SEABORN/FELS 2015, p. 28) and can be repeatedly applied in every usage context, is a *phantasmagoria*.

Maybe the critique of gamification in terms of a lack of a unified discourse and the plurality of gamification frameworks and theoretical backgrounds (like objected to in SEABORN/FELS 2015), as well as the possibly high development efforts, the lack of gamification solutions and problems regarding measuring or guaranteeing effects (see HERZIG et al. 2015) should therefore not be subject of critique but be seen as mere *expression* of the notion of gamification as a design strategy.

Keeping the outlined problems and restrictions in mind, a few preliminary arguments for utilizing gamification as a viable design strategy are outlined in the following.

1) *The motivational power of games is still undisputed*: the central claim of gamification to motivate and engage users with the help of game design elements, or from a marketing perspective, to enhance the (perceived) value of a product by affording gameful experiences is well grounded (see Ch. 3.4), as games are "a pinnacle form of hedonic self-purposeful systems" (MORSCHHEUSER et al. 2017).

2) *Gamification has been already successfully implemented:* as a variety of examples show, gamification, if well-designed, can work (for an overview see SEABORN/FELS 2015; for the important domain of crowdsourcing see MORSCHHEUSER et al. 2017). Even approaches focusing on extrinsic rewards, pejoratively labeled as "pointsification", can, if clever designed, reach intended goals. From a theoretical point of view, external incentives are even necessary to expose people to activities not perceived as intrinsically interesting and "might allow the person to experience the activity's intrinsically interesting properties, resulting in an orientation shift" (RYAN/DECI 2000a, p.63).

3) *Gamification allows a shift from product features to user experience*: as open data initiatives and free mapping services are spreading, product features and core services are becoming less and less important, whereas design choices or from a user's perspective, experiential qualities of products, are crucial. As GARTNER (2018b) predicts, "half of all consumer goods product investments are likely to be

> directed toward improving the customer experience", labeling customer experience a "digital priority".

After discussing the concept of gamification intensively and from different perspectives, ranging from definitions, related concepts, its underpinning theory, to game design and the implementation process of gamification as well as possible problems, restrictions and critique, it is now time to address the manifold relationships between gamification, its related concepts and the cross-disciplinary field of cartography and GIScience.

4 Gamification and related Concepts in the Context of GIS(cience) and Cartography

In this chapter, after a general discussion of the gamification concept, gamification and related concepts are revised in the context of GIScience and cartography. First, existing theoretical and practical engagement with gamification, its predecessors and related concepts are discussed, as the concepts can not be thought of as rigid categories and overlaps exist. The gamification discourse, in a narrower sense, is dissected in greater detail — both regarding theoretical engagement and existing applications and prototypes — in order to show possible problems or limitations regarding the practical use and theoretical reflection with respect to gamification in the field of study. Possible points of contact to existing concepts and theories in GIScience and cartography are indicated to show how gamification can be integrated into the theoretical field of discourse more thoroughly as it has been to date. Finally, as a synthesis out of the previous sections of this chapter, the potential of gamification in the field of study as well as possible research agendas, are introduced.

4.1 Contributions from the Field of Cartography and GIS(cience)

In the following the classification scheme proposed by DETERDING et al. 2011 is used to categorize theoretical contributions as well as prototypical implementations in the field of cartography and GIScience. Although, definitions of gamification vary (see Ch. 3.2), it is arguably beneficial to analytically separate the use of game elements from the use — in terms of reaching intended design goals — of full-fledged games (i.e. serious games), as well as — though overlapping with full-fledged games — the extending of games (pervasive games[6]).

Furthermore, DETERDING et al. 2012 propose a more fine-grained differentiation in the use of game elements in non-game contexts apart from gamification, ranging from the *use of game technology* like graphic engines and authoring tools of video games for scientific visualizations and 3D environments to practices in a wider ecology of games like *serious gaming* (p. 12), i.e.:

> *"All of the technologies, practices, literacies and social processes surrounding games, like reviewing games; producing machinima; or designing virtual items, avatars, levels or whole games."*

6 Pervasive games "extend the gaming experience out into the real world" (BENFORD et al. (2005, p. 1), "blur the boundaries between itself and the real world", thus can be understood as "an overlay of the real world", as the "world becomes a game board" (NIEUWDORP 2007, p. 3). A prominent example of a subcategory of pervasive games, location-based games, is Pokémon Go.

In a recently published edition of *Advances in Geographic Information Science,* titled "Geogames and Geoplay", a definition for the "emerging research field" of geogames and geoplay is intruduced (AHLQVIST/SCHLIEDER 2018, p. 1-2):

> *"[…] all games and play that uses real geocontent and is mediated by GI technology."*

This definition of geogames and geoplay as wide umbrella terms is proposed, as no standard definition of "geographic gameplay" has emerged yet (p. 2). However, the proposed definition should be dissolved into DETERDING et al.'s (2012) for the following reasons:

1. The definition is *to open:* due to its character as an umbrella term, different arguably distinguishable concepts are melded into one broad definition. A look into the volume showed that using the proposed terms, gamification, the use of game technology (depicting landscapes) as well as serious games for different purposes (consensus building, spatial literacy etc.) are subsumed under the terms "geo games" and "geoplay". Interestingly, even gamification, as the use of game-elements, seems to fall within a definition that apparently emphasizes (full) games.

2. The definition is *shortsighted*: in the light of an increasing convergence of GI and game technology (e.g., BORNEMAN 2014, SHEPHERD/BLEASDALE-SHEPHERD 2009) the given definition's emphasis on mediation by GI-technology may prove obsolete.

3. The definition is a *drawback*: apart from neglecting the discourse about serious games, gamification and its predecessors, in contrast to concepts like gamification and serious games that explicitly argue for the use of games or game-elements in different contexts, the only criterion of identification for geogames seems to be the use of "real geocontent". However problematic the proposition of "real" geocontent may prove in detail, it is even questionable if the distinction between "real" geocontent and "fictional" worlds can be a plausible criterion to differentiate games from geogames: for example, does the depiction of real terrain or a high-resolution 3D-city model (if that models were created or processed with GI technology) in an ego-shooter automatically make it a geo-game or is it not more plausible to label it a (commercial) video game with "real" geodata in the background? The use of "real geocontent" seems not to be sufficient (or even necessary) to express the notion behind geogames, i.e. *using* games for different *purposes.* Exactly one of these purposes could be (but is not limited to) depicting terrain in an video game engine or using games or game elements for teaching spatial literacy or critical spatial thinking. Thus the "geo-purpose" not the "geo-data" or "geo-technology" should be the criterion to differentiate geogames from games, even at the cost of kicking off a discussion regarding contents and scope of the interdisciplinary field of GIScience.

Due to the outlined points of critique, the terminology proposed by DETERDING et al. (2012), enriched with the prefix "-geo", to point out the application scenario in the broader field of discourse of GIScience, was used to classify respective contributions. Though it should be noted that many contributions combine projects — often in the form of prototypes, with theoretical reflection, thus making it impossible to strictly classify contributions. Furthermore, the hybrid nature of applications, as well as overlapping categories or subjective attribution aggravate such an endeavor. Nonetheless, as a heuristic tool to outline paths, gaps and potential of research such a classification seems feasible. It should be noted that this overview does not claim to be comprehensive, often only initial and exemplary work was considered. However, the conclusions drawn from this investigation do not suffer from one-sidedness.

Category	Subcategory	Example(s)
Game Elements	Game Technology	Use of game engines for geovisualization (e.g. FRIESE et al. 2008, OLEGGINI et al. 2009), depicting landscapes (HENRY 2018) or 3D cartography (CORBETT/WADE 2005)
	Gameful Design (Geo-Gamification)	“Gameplayer”-metaphor for accessing and visualizing geoinformation, e.g. in the form of game-like user interfaces (CARTWRIGHT 1999/2006) Use of “game elements” in cybercartography (TAYLOR 2003) Use of Interface metaphors for effective interaction in 3D data visualizations (SHEPHERD/BLEASDALE-SHEPHERD 2008) Use of game elements or patterns in geo data collection (VGI, crowdsourcing) and actualization (KELLER 2013, SALK et al. 2015,GARCIA-MARTÍ et al. 2013 ANTONIOU/SCHLIEDER 2018)
	Game Practices (Serious Gaming)	Evaluation of user comments/feedback of cybermaps in videogames to improve (cyber-) cartographic visualization (GREENSPAN 2006)
Full-fledged Games	Serious Geo-Games	Modification of a commercial role-play game for multi-perspective presentation of geographical “facts” (DORMAN et al. 2006) Serious PPGIS game “B3 – Design your Marketplace!” for civic engagement in urban planning (POPLIN 2014) Serious GIS (SerGIS) geogame framework for flexible development of geogames, originally used for disaster management training (TOMASZEWSKI et al. 2016 / TOMASZEWSKI/SCHWARTZ 2017)
Fullfledged Games / Extension of Games	Serious Pervasive Geo-Games	Geographic Information Systems Multiplayer Online Games (GIS-MOG) as integration of GIS and online multiplayer game technologies (AHLQVIST et al. 2012/2018)

Table 6: Contributions from the field of cartography and GIScience to gamification and related concepts (Source: own)

4.1.1 Game technology

The main research trajectory in utilizing *game technology* in the field of discourse is arguably the use of game engines for the joint purposes of geovisualization, 3D-cartography and depicting landscapes in virtual environments (for references see Table 6), although projects with additional analytical purposes have been carried out as well, e.g., georeferenced auralization and tracking of certain parameters calculated by the game’s physics engine depending on the user’s path of motion (MANYOKY et al. 2014).

Basic arguments for using game engines in the outlined areas are the ability of real-time visualization without time-consuming rendering, enabling of free movement and dynamical modification of different parameters (ibid.), low costs compared with professional visualization tools, multi-user functionality, AI, state-of-the-art graphics (FRIESE et al 2008) as well as user-immersion and sense of presence (HENRY 2018). Though limitations exist regarding data import as well as associating map data with external attribute data for example from databases (CORBETT/WADE 2005).

A generalized workflow (cf. PRINZ 2015, p. 31) for the use of game technology within the domain of cartography and GIScience is depicted in Fig. 4. The game engine, as the figure shows, is the crucial point within the workflow, as not only engine-specific restrictions regarding the import of geodata exist (e.g., maximal resolutions of digital elevation models (DEM) or no import of vector data), but also — if not only a simple visualization of imported geodata within the game-environment is envisaged — regarding the permission of external add-ons or plug-ins, which, in turn, may have to be custom-made for the specific application in mind.

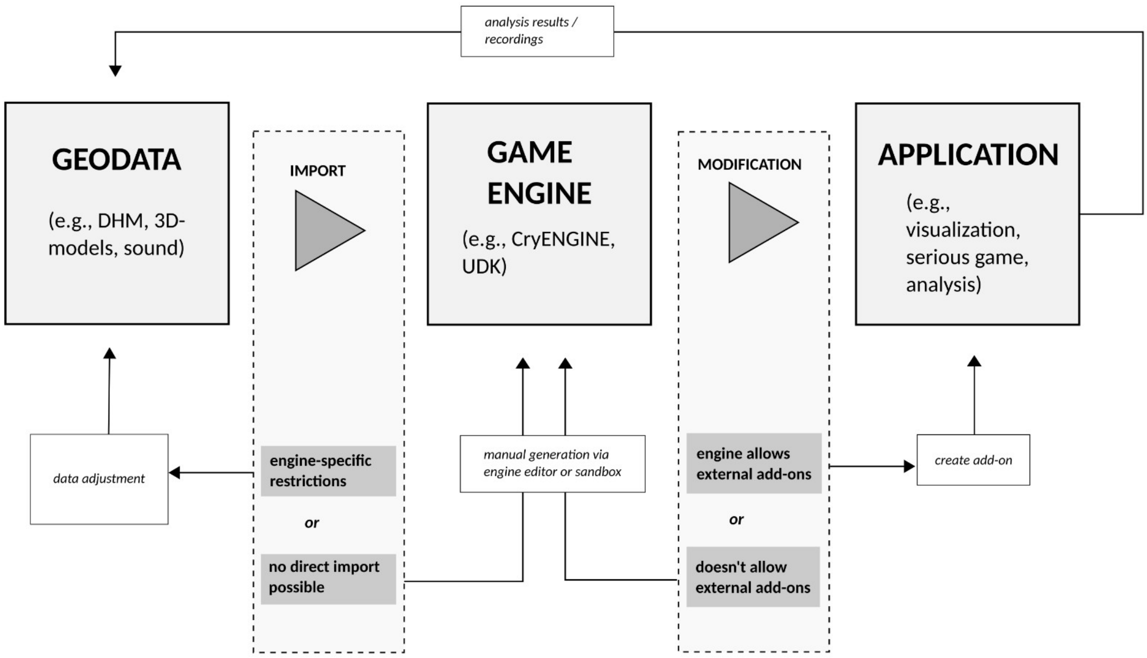

Fig. 4: Generalized workflow for the use of game technology in GIScience and cartography (PRINZ 2015, p. 31)

4.1.2 Serious Gaming

Probably the most striking case of serious gaming in the field of discourse was presented by GREENSPAN (2005). In his paper the author argued for an evaluation of user commentaries, feedback and critique of existing cartographic interfaces in digital games. The basic argument is that cartographic representation in cultural artifacts like computer games create cultural expectations that not only exceed what is currently technically possible at the time but also “shape the way users approach the cybermaps of the future”

(p. 309). The users of such digital games thus provide “valuable insights into the effective and appealing design of mapping interfaces” (p. 313). Areas of research GREENSPAN (2005, p. 317) argues could be covered encompass primary usability issues of cartographic interfaces like the appropriate balancing of realism and abstraction, assessing different metaphors for geovisualization, as well as determining the best mix of geographic and statistical data.

Complementary to traditional empirical usability testing, the evaluation of user commentary and feedback, as canned direct feedback of geographic interfaces in digital games that GREENSPAN (2005) conducted in the form of usenet lists of the video game SimCity, may prove a promising approach for evaluating and improving digital maps.

4.1.3 Serious Geo-Games and Serious Pervasive Geo-Games

Games with a more or less explicit geographical setting like for example “Where in the World is Carmen Sandiego?” or “SimCity” have a long tradition of being utilized for different purposes apart from gaming (e.g. JOHNSTON/CARTWRIGHT 2000, p. 68). However, the stand-alone creation of serious games for purposes situated within the field of discourse seems to be a phenomenon of the last ten to fifteen years, mainly sparked by advances in technology (e.g., Desktop-GIS, GNSS, Smartphones, Web-Mapping) as well as concepts and methods utilizing these technological advances like Cybercartography and VGI (see Ch. 4.2.1). In the following, several projects are introduced to outline different research trajectories and application scenarios regarding serious and serious pervasive games.

DORMAN et al. (2006) modified a commercial role-playing game, Neverwinter Nights, for the purpose of education. Explicit goal of their project *Neverwinter Nights in Antarctica* was, in the light of the cybercartography concept, to create a pedagogical game as part of a cybercartographic atlas, that encourages critical thinking using multiple perspectives. Multiple perspectives, in terms of different camera angles or POVs (point of views), different game narratives as well as the element of role-play (p. 52) should encourage the users to critically involve with the topic of climate change. Particularly, as players are confronted with different perspectives on the same event or play the game with different characters, reflexivity and dissonance may create learning opportunities for the players (p. 52) as well as offering a “radical challenge to scientific truth by showing conflicting voices and perspectives” (p. 53). Especially in light of the cybercartography concept, this approach may prove helpful to criticize the “false objectivity of maps” (TAYLOR 2005, p. 6), which lets the map author’s point of view appear as an omniscient and author-less point of view (p. 54).

Serious Geographic Information Systems (SerGIS), originally a “serious GIS spatial thinking game” (TOMASZEWSKI et al. 2016), developed for training of disaster management personnel in terms of GIS for disaster management and general spatial thinking skills, was further extended into a geogame framework for flexible development of geogames (TOMASZEWSKI/SCHWARTZ 2017). The authors theoretical framework in the early version of SerGIS is based on elements of spatial thinking (e.g., concepts of space, tools of representation, and processes of reasoning) operationalized as spatial thinking concepts (e.g., buffer, location, distance). These concepts are thought of being correlated with GIS operations, which are ultimately used to answer the scenario questions in the SerGIS game (TOMASZEWSKI et al. 2016). Starting as a script within ArcGIS, SerGIS evolved into a web-based geogame environment allowing custom authoring of game scenarios (TOMASZEWSKI et al. 2018, p. 377). Although the development is limited to the creation of a series of game question and answer prompts, allowing only the authoring of the background map and features as well the content and choices of each prompt (ibid.). The game is thus similar to a multiple-choice quiz with an interactive web-map in the background to solve the questions, thus game elements are limited to points, rewarded for correctly solved questions, and a provided game narrative.

The basic notion behind the *Geographic Information Systems-Multiplayer Online Games* (GIS-MOG) Technology Framework has been described by the authors as attempt to combine online maps with board games for geographic learning as part of a Cyberlearning program (AHLQVIST et al. 2018, p. 20). As a special technology configuration, the project fusions “GIS-supported map and processing services” with online multi-player affordances (ibid., p. 24). Similar to SerGIS, various prototypes utilizing different technological frameworks have been developed. The most recent version is designed for an introductory Geography course regarding the Green Revolution in India. In a turn-based game, where each turn represents a growing season, players take the roles of farmers and can buy, develop and cultivate farmland parcels based on an actual aerial photo map. Harvested yield can be sold at a marketplace, the player with the most accumulated capital wins the game (ibid., p. 22-23). A central characteristic of the GIS-MOG framework is thus its pervasiveness, as real-world data is the basis for game interactions, rule and mechanics.

POPLIN (2014) developed a serious game for civic engagement in urban planning, “B3 – Design your Marketplace!”. The game, set in the city district of Billstedt in Hamburg, Germany, focused on collaborative design of a marketplace. B3 (Bürger-Beteiligung-Billstedt) (p. 493):

> *“Aims to provide a playful digital environment in which citizens gain information about the current situation in the city district, have the possibility of submitting their own designs for the marketplace, vote for the preferred designs, and chat with the experts and other participants.”*

The basic notion behind B3 is to use “playful elements” in a participatory environment to engage and enable immersion of citizens in participatory processes, as most citizens tend towards a “rational” attitude regarding public participation processes (e.g. to trade off the costs of educating oneself against the potential benefits) (p. 495-496). The game, designed in Adobe Flash, comprises static 3D models of real-world buildings, dynamic objects to be placed on, manipulated and deleted from the marketplace, a little helper to give information to the player, as well as functionality for chatting with other players and urban planners and rating designs from other players (p. 501 – 502). Although one of the goals of the project has been to provide a platform for "immersive and playful learning" (p. 499) about an urban planning situation, B3 can be, together with similar, preceding projects, evaluated as pushing the usage scenarios of serious games within the field of discourse into the domain of public participation GIS (PPGIS).

Especially the last two projects, GIS-MOG and B3, show how problematic disjunctive categories may prove in the classification of contributions. Against the intentions of the author, B3 could arguably be described as gamified PPGIS or urban design application, as the nature of B3 as a "full-fledged" game could be questioned. GIS-MOG, on the other hand, may be, justifiably, either be judged as a pervasive game and thus just an extension of games, or as a serious game with pervasive elements. Nonetheless, core themes of serious games in the context of GIScience and cartography to be extracted, encompass the interrelation of learning, training, education and planning.

4.1.4 Geo-Gamification

The "*early beginnings"* of theoretical reflections regarding the use of game and play — in the widest sense — taking place within the field of discourse, can be contributed, among others (e.g., KUHN 1992), to CARTWRIGHT (e.g. 1997, 1999). Though CARTWRIGHT does not explicitly refer to the related concepts of gamification or serious games, mainly because it was too early for them to be either coined or to enter the general scientific discourse, some of his works can be classified as non-explicit works on gamification within the domain of GIScience and cartography. More specifically, CARTWRIGHT (1997, 1999) proposes, in the light of the emerging of multimedia cartography, to complement traditional map-based products with a set of different access metaphors (1999, p. 337). These metaphors, integrated into a *GeoExploratorium,* an interactive multimedia product (p. 347), should enable users to explore geographic information as well as to "to support their map use through multiple forms of information access" (p. 337), indicating the duplicity of visualizing and accessing of geographic information in terms of functionality of metaphors (see CARTWRIGHT 2006, p. 32). Of exceptional interest is only one of the proposed metaphors, "*the Gameplayer*". CARTWRIGHT (1999, p. 344), in an almost tautological attempt to define this metaphor, speaks of the "use of gaming skills to explore geographical information" in contrast to "playing of games per se" (p. 345), geographical information packages should be designed "to access gameplayer methods", although he illustrates the definition by examples referring to different game genres, like to move through a virtual landscape while avoiding pitfalls in action games, the navigating through such a world by means of unlocking clues by solving puzzles, as well as the creation of a comprehensive report on a geographic region with the help of multimedia tools as based on entertainment games (p. 345). In a later paper, CARTWRIGHT (2006) explores the potential of a game-like user interface for accessing geographic information, arguing that the familiarity of such an interface makes it more suitable for certain user groups. Although explicitly referring to the gameplayer metaphor, such an undertaking, to use arguably the least game-like thing of a game, its user interface, for other purposes than gaming, falls back behind its own conceptual aspirations and possibilities, and, in a way, mirrors the discussion about “pointsified” gamification (see Ch. 3.8.1). Similar to CARTWRIGHT (2006), SHEPHERD/BLAESDALE-SHEPHERD (2008) look into interface metaphors in video games, arguing that “greater usability in VGEs (virtual geographical environments) can be achieved by exploring a category of software in which usability has become a key criterion of effectiveness” (p. 19). But unlike CARTWRIGHT, the authors provide a detailed analysis of interface metaphors for 3D environments and even provide two general suggestions for the design of effective interfaces of VGEs.

CARTWRIGHT‘s ideas of an interactive multimedia product (GeoExploratorium) that combines different access metaphors can be found in similar fashion, but with stronger conceptual embedding, in the concept of *Cybercartography* and its cybercartographic atlases. TAYLOR (2003) argues with respect to one main element of the cybercartography paradigm (see Ch. 4.2.1) — to be “highly interactive and engage the user in new ways” (p. 407) — that cybercartographic products should be “dynamic, innovative and entertaining” (p. 411). Referring explicitly to the concept of edutainment (see Ch. 3.3.1), which should be integrated into cybercartography, TAYLOR (2003) argues furthermore for the incorporation of “gaming” elements into cybercartography (p. 411). Similar to CARTWRIGHT (1999), TAYLOR (2003) does not consider to define or elaborate what exactly “gaming” elements are, but merely points to the need for further examination of “software, hardware and content of computer games” (p. 412).

In summary, as the discussion of two exemplary exponents of the early phase of theoretical reflection shows, it can be said that the beginning discourse was characterized by:

- A superficial or no referring to existing or evolving concepts like serious games, gamification and edutainment, therefore only vague presumptions regarding the usefulness or potential of using games or game elements in different contexts have been made.

- A seemingly meager understanding of games and their elements, completely uninformed by game and game design theory and literature.

- A strong “concept paper”-character, as authors try to open up cartography and GIScience to new formats and interaction modes. Innovative thinkers at their time, they pushed the idea of using games, game elements and technology into the field of discourse and opened it to a wide array of usage scenarios.

The next phase of theoretical discourse can be characterized by an emphasis on trying to analyze video games and video game technology regarding their usefulness and potential within the field of discourse. In contrast to the early phase of theoretical reflection, where only superficial referencing or nearly tautological definitions were given, video games have been taken seriously as distinct media, as their properties, both technical, in terms of game technology, and functional, in terms of game mechanics, rules and different game genres (e.g., CHAMPION 2007), have been subject to closer examination. Furthermore, the attempt to discover analogue elements between cartography or GIS(cience) and video games play an increasingly important role, may it be to understand something previous unknown in a known theoretical language, to appeal to a scientific audience, or to argue for a potential research field. Exemplary for this kind of research have been the papers by AHLQVIST (2011) and SHEPHERD/BLEASDALE-SHEPHERD (2009).

AHLQVIST (2011) outlines five major themes in video games and computer cartography and argues for the potential of "combining modern cartographic theory, tools, and practice with gaming approaches" (p. 278) in these respective themes. These "connected trajectories" are *spatial analysis*, as there exist interesting parallels between an analytical view on cartography and "the use of regular grids and topology in games" (p. 280), *multi-user environments*, providing possibilities for collaborative development and sharing of ideas and tools (p. 281), *increased realism* of products both in terms of computer games and cartographic products, *designed worlds*, as cartography should consider digital modeling of existing landscapes for the purpose of scenario building, similar to computer games, where game maps are often fictional or modified to support gameplay (p. 282-283), as well as an "increasing need for and work with" *content standards and data semantics* (p. 283-284). Unlike AHLQVIST (2011), who's focus arguably lies more on finding starting points for combining cartographic tools, theories and methods with "gaming approaches" (p. 284), SHEPHERD/BLEASDALE-SHEPHERD (2009) deliver a head-to-head comparison of GIS(cience) and video games, with a strong focus on potential of video games in terms of their ability to contribute to GIS(cience). The authors argue mainly for three areas "in which VGs can contribute in a significant way to GIS" (p. 14): *dynamic process modeling, user interaction and multi-sensory data representation*. In contrast to GIS, where dynamic representation can traditionally be described as a "data-driven process, where the data are the outcome of prior surveying or monitoring activity" (p.15) or the outcome of real-time data capture, video games store a relatively small amount of time-varying data but encompass many dynamic process models providing the environment to appear realistically and behave in a realistic fashion with respect to player interaction (ibid.). Similar to CARTWRIGHT 2006, the authors argue for video games as a "huge experimental laboratory for interface design" as thousands of games are released each year (SHEPHERD/BLEASDALE-SHEPHERD (2009, p.19). These ideas should be used to "developing more effective methods for spatial exploration, search and interrogation" (p. 20). Furthermore, the authors provide a few examples of video game interface ideas with regards to their potential in GIS, e.g. the availability and often seamlessness of switching between different viewpoints (first-person, third-person, and god viewpoint) (p. 21). As it can be seen for example in TAYLOR's (2003) cybercartography concept (see Ch. 4.2.1), multisensory representation of data is a vibrant topic in geovisualization and GIS(cience). Video games are, arguably well advanced regarding the effective combination of multi-sensory information, as the use of audio to reinforce visual information or to provide locational information, as well as haptics in terms of vibrotactile feedback via controllers or other interface devices, show(p. 25-26).

Although games and their elements have been subject to a more detailed analysis in this phase of theoretical discourse and first reflections regarding the usefulness of certain elements in specific contexts have been undertaken, the following points of criticism remain:

- Again, there seems to be no referring to existing or evolving theoretical concepts like edutainment, serious games or gamification, therefore theoretical compatibility to related research does not exist.

- The theoretical approaches can be described as being strongly technology-focused. It is not clear *why* (except from being technologically advantageous) and even *how* (in terms of technology and application design*)* certain game elements or features should be applied in the context of cartography and GIScience.

- The comparative and contrastive character of the respective scientific papers leaves, though giving the professional audience an understanding of the potential of using game elements, no room, except from vague outlines, for discussing *specific* usage scenarios or contexts.

Powered by the hype surrounding gamification and serious games (see Ch. 3.8.3) and the advent of first successful gamified applications, the next phase of engagement with gamification and related concepts can be described as being mainly concerned with prototypical application building. Specific application contexts, especially within the domain of VGI, crowdsourcing and PP-GIS were discovered. As for the aforementioned reasons, not much effort was put in justifying the use of game elements in specific non-game contexts. The discussion in the respective fields was overlooked, prominent but disputed figures like ZICHERMANN (CUNNINGHAM/ZICHERMANN 2011) were cited (e.g., KELLER 2013, p. 253/ ODOBAŠIĆ et al. 2013, p. 330 – 332, GARCIA-MARTÍ 2013, p. 2), which ultimately lead to methodological limitations regarding the used game design elements, something that been referred to as “pointsification” (See Ch. 3.8.1 and 3.8.2).

Exemplary for such an approach is the paper by KELLER (2013). The author introduces *Kort*, a location-based mobile web-application based on crowdsourcing and enriched with game design elements (p. 254). The basic idea behind this application is to enhance user motivation to participate in correcting errors and adding missing data in the OpenStreetMap database. Game design elements used are restricted to points (awarded for accomplishing missions), challenges (missions, e.g., to enter the missing name tag for a restaurant), badges (awarded for certain tasks, e.g., to complete 10 missions) and leaderboards (a highscore of the Top 10 users including ones own rank) (p. 254-255). Kort is in that regard no aberration as a review of different services within the field of gamification of geographic data collection conducted by ODOBAŠIĆ et al. (2013) showed. Although it should be noted, that the paper suffers from a bias, as its categories of analysis are inherited from pointsified gamification, thus preventing to see abstract game design patterns. In similar fashion, but not location-based, the so called Cropland Capture game

(SALK et al. 2015) — a gamified geographic data collection environment for classifying satellite imagery, ultimately to “improve global cropland mapping” (p. 3) — used a “pointsified” approach. Users labeled imagery in order to be rewarded points, which were kept track of at a scoreboard (highscore). At the end of the game real world prizes were awarded (p. 4). Within a related context — crowdsourcing of environmental noise data via a gamified mobile application — *Noise Battle*, GARCIA-MARTÍ et al. (2013) combine game elements of pointsification towards more abstract game design patterns, however due to the theoretical grounding in pointsification (see p. 2) the concepts used were not expressible within its theoretical language: Players are not simply rewarded with points and badges for noise measurement tasks, but are engaged in different location-based game tasks: the city map is divided into cells of a grid, which players can allocate “by taking more and better measurements” (p. 2), ultimately leading to certain rewards within the application environment (sending noises to other players, unlocking of levels). The basic motivation behind Noise Battle was, again, to enhance user motivation and long-term participation geographic data collection as they take part in this simulation of a virtual conflict about conquering as much cells of the grid as possible (p. 2). However, no further theoretical grounding to answer why this specific combination of game design elements might be motivating in this specific context and no empirical evaluation was conducted to attempt to validate users long-term motivation.

To summarize, the discourse regarding gamification developed from simple calls for conceptual consideration of games and game elements, over early prototyping — uninformed of game design and gamification theory — and more detailed analyses regarding the potential of using video games and their technology, to a stage of advanced application building in certain application areas, though lacking thorough theoretical underpinning. The literature review showed that the subject-specific discourses suffered from a duplexity of limitation, whose tackling could provide progress in the domain of cartography and GIScience.

- The discourses suffered from *methodological limitation*: starting from no theoretical compatibility to established concepts or no mentioning of game design theory whatsoever, the gamification and serious games concepts, respectively, provided catchy umbrella terms to subsume different particular research interests as well as to provide an opportunity to outsource necessary theoretical grounding for prototypes. But these links remained superficial and arbitrary, as gamification, if mentioned at all, was reduced to pointsification and no, a random combination of elements of, or only mechanistic gamification frameworks have been used in the design of applications, leading ultimately to a wide open gap between theory and practice. Although, as the discussion regarding the general discourses around gamification showed (see Ch. 3.6 and 3.8.4), the coupling of theoretical frameworks and application design, as well as the lack of a unified discourse and methodology remains still an issue in gamification research and leads to an often eclectic or arbitrary combination of theoretical set pieces of gamification theory or game design elements without proper notion or even measurability of effectiveness in practice.

- The discourses suffered from *practical limitation*: application design, apart from early exploratory prototypes concerned with game-like interfaces — often only barely connectable to the gamification concept — can be described as iterations of the same interrelated topics of VGI, crowdsourcing and geographic data collection. Other application scenarios, such as educational and training settings, found mainly in the context of serious games, play only a minor role. The use of gamification is justified through the claim that it provides an effective tool to motivate users to provide data, but as it was outlined before, methodological limitations lead to problems sustaining such a claim in detail.

In order to tackle this duplexity of limitation it is first necessary to engage on a deeper level with game design and gamification theory, its frameworks and underpinning theories. Gamification has to be treated not as a method, blindly applicable to every context, but as a design strategy that involves careful consideration of game design theory and practice (see Ch. 3.8.4). A first step towards this direction was given by ANTONIOU/SCHLIEDER (2018), who, though still thematically focused on VGI, address the problems of uneven participation patterns, i.e. the problems of commitment to, the update of and the clustering of OpenStreetMap (OSM) features (p. 108), through the use of “gamification mechanisms” (p. 91). Not only was the gamification concept questioned regarding its capacity to solve very specifically defined problems in the context of GIScience and cartography, but the units of analysis have also not been on the most superficial level (e.g. points, badges, leaderboards) as certain game design patterns serving the purpose of allocation or deallocation of places (p. 92) were taken into consideration. The participation issues were further mapped onto specific design patterns, and even an agent-based simulation was conducted to analyze the game flow. Although, the methodology still seems to suffer from mechanistic thinking, i.e., a rationale of “use pattern x to get response y”. The importance of interrelation of different game design patterns on different levels of abstraction (e.g., components or game models) was not considered and it is nor clear how to best implement the analyzed game design patterns to encourage users to engage with the application, which has to be considered the central claim of gamification.

Secondly, to tackle *practical limitations* regarding possible usage scenarios for designing geospatial applications, it is necessary to provide points of contact to existing concepts and methods of cartography and GIScience, which, in term could inspire future fields of application. Partly, certain papers, already discussed in this section, either from proponents of different theories or concepts (e.g., cybercartography) or from design-centered authors developing prototypes, indicate such possible ties. In the next section a non-exhaustive outline of points of contacts is explored in greater detail.

4.2 Points of contact to existing concepts and methods

The notion of gamification as a design strategy — the view that this thesis takes — entails that gamification is arguably neutral and applicable to every kind of geospatial application. However, as the last section showed, the discourse regarding gamification within cartography and GIScience suffered from practical limitations. To combine with chapter 3, where gamification has been analyzed regarding its general potential, this section takes a perspective from within cartography and GIScience to look for implicit and explicit conceptual ties to and justifications for the use of game (design) elements. It should be noted that this chapter has only cursory character and points to *possible* points of contact, which still have to be elaborated in greater detail. However, this chapter could form the basis for distinctive research agendas, that go beyond the contemporary attempts that have been outlined in chapter 4.1. Apart from answering the question regarding *why* to use gamification from an *inside* perspective, this section attempts — in accordance with the general goal of theoretical work — to extent the possibility space for future application scenarios or even anticipate them.

Beforehand, it is necessary to point out a few significant developments that gave rise to the use of gamification within the domain of cartography and GIScience. Many of these developments were conceptually or technologically taken up or put to use in a geospatial variety. First, a shift towards *multimedia and interactivity* of cartographic products (e.g., CARTWRIGHT/PETERSON 2007) was fueled by a growing diffusion and graphical processing power of computers. Furthermore, with the combined rise of *Web 2.0* and ubiquitous smartphones equipped with GPS-technology, the creation and dissemination of user generated content in the “social web” led to “collective cartographies” (CAQUARD 2014) associated with catchphrases like *volunteered geographic information* (VGI) (GOODCHILD 2007), as a geographical form of voluntarily contributed user generated content, *crowdsourcing* (HOWE 2006), community mapping efforts like OpenStreetMap (OSM) and public participation GIS (PPGIS) (e.g. KINGSTON et al. 2000). Alongside these phenomena, which rely on a crowd of people motivated to work on tasks for no or little monetary compensation, gamification proved a “natural” complement as the increasing gamification of crowdsourcing systems shows (MORSCHHEUSER et al. 2017, p. 26). Related to these developments, the traditional distinction between expert and non-expert regarding the creation of geographic information is increasingly breaking down, a process that has been labeled “neogeography” (TURNER 2006). This “neogeographical” turn, combined with a heading off from the traditional map communication model and its search for the *one* optimal map (cf. GLASZE 2009, p. 182; CRAMPTON 2001, p. 237), paved the way for user-centered design in cartography (see Ch. 4.2.2).

4.2.1 Cybercartography and Multimedia Cartography

Explicitly mentioned already in the sections covering the contributions from the field of cartography and GIScience in terms of serious geo-games (see Ch. 4.1.3) and geo-gamification (see Ch. 4.1.4), *cybercartography* played a role in earlier contributions to justify the use of game elements and inspire innovative applications as part of cybercartographic atlases (cf. TAYLOR 2003, DORMAN et al. 2006). Such justification, as it was shown, can be derived from an explicit mentioning of the use of “gaming“ elements in cybercartography (see TAYLOR 2003, p. 411) as part of one of cybercartography‘s “major elements“: its “highly interactive“ nature and attempt to engage “users in new ways“ (p. 407).

Despite the debate regarding the theoretical status of cybercartography in terms of being describable as concept, paradigm or paradigm in the sense of KUHN (1976) (e.g., see HRUBY/MIRANDA GUERRERO 2008, p. 3), cybercartography provides, in its self-understanding, an answer to the challenge of the rise of digital information technologies to traditional cartography, a necessity to “move away from narrow ‘technological’ normative and formalistic approaches to cartography to a more holistic approach where both mapping as a process and the map as a product are expanded” (TAYLOR 1997, cited in TAYLOR 2005, p. 2). Cybercartography thus provides a new definition of cartography as (TAYLOR 2003, p. 406):

> *“The organization, presentation, analysis and communication of spatially referenced information on a wide variety of topics of interest and use to society in an interactive, dynamic, multimedia, multisensory and multidisciplinary format.”*

The shift from supply-driven cartography to a “demand- or user-driven approach” (TAYLOR 2003, p. 407) inspires the characterization of seven major elements of cybercartography, partly indicated in the definition above (p. 407): It is “multisensory” (use of vision, hearing and touch, possibly smell and taste); “uses multimedia formats and new telecommunication technologies”; it is “highly interactive and engages users in new ways”; is “applied to a wide range of topics of interest to society”; as “part of an information/analytical package” it is “not a stand alone product like the traditional map”; is “compiled by” interdisciplinary teams; and “involves new research partnerships among academia, government, civil society and the private sector”. Although not explicitly mentioned within its major elements, cybercartography emphasizes the close link between theory and practice, which are not thought of as discrete processes but to influence each other through a “series of ongoing and iterative feedback loops” (TAYLOR 2005, p. 2). The “main product” of cybercartography are so called cybercartographic atlases “a metaphor for a new form of organization, analysis and presentation of a wide range of information that is referenced by location […] built from clearly defined conceptual models and semantic ontologies” (TAYLOR/PYNE 2010, p. 6).

Similar to cybercartography, the concept of *multimedia cartography* was developed in the light of aforementioned technological advances. The basic notion can be described as a “search for better ways to represent the spatial reality” because “existing methods” are thought of as “inadequate” (PETERSON 2007, p. 67). In the five basic principles of multimedia cartography related topics are addressed, although with a stronger focus on arguing against the paper medium. Multimedia cartography should — realizing the problems and inadequacy of the paper medium — focus on offering multiple views and alternative methods of representation, encompassing interactivity, animation, as well as being targeted to specific users (ibid., p. 69). Multimedia cartography should also take its “moral obligation of cartographic communication” seriously in bringing “map use to a larger audience" (p. 71). A basic conceptual claim of multimedia cartography is that multimedia provides intrinsic value and leads "to improved information and knowledge transfer" (p. 69), although the author admits that "true experimental foundation of such assumptions and beliefs is incomplete and often weak" and a "coherent theoretic basis explaining why multimedia is supposed to work" has not been founded (p. 70). To contrast the concept with cybercartography, it seems that cybercartography encompasses many facets of multimedia cartography but is embedded in a much clearer and well formulated framework, whereas multimedia cartography seems to have a strong "programmatic" character.

If the usage statistics of the term "cybercartography" are taken as indicator, it can be argued, that the concept of cybercartography as well as multimedia cartography, are not present anymore within the cartographic discourses (cf. WOLODTSCHENKO/HRUBY 2011). However, if it is true what TAYLOR says, that the concept of cybercartography has been implemented and built on (ibid.), thus is already implicit in contemporary theory and practice, the more important it is to uncover these explicit theoretical points of contact as cartographic practice is working off implicitly on this heritage.

4.2.2 Cartographic Interface and Interactivity Design

The use of game design elements in cybercartography was justified through aiming at high interactivity and user engagement in cybercartographic products. It is also possible from within a decidedly design-oriented perspective, focused on cartographic interfaces and interactivity, to argue for the use of game design elements in geospatial applications.

Cartographic interaction — defined as "the dialogue between a human and a map mediated through a computing device", where human and map are considered "equals in the cartographic interaction, each holding the ability to affect change on the other" (ROTH 2013, p. 64) — is arguably fundamental to modern digital cartography. Within such a framework, each component of the interaction conversation can be focal point of design attention, i.e. an interface-centered, a technology-centered or a user-centered perspective.

However, an interface-centered perspective alone cannot account for difference in cartographic interaction strategies and performance, which may only be explained by individual user differences (ROTH 2013, p. 74). In this user-centered perspective of cartographic interaction an attempt is made to "improve cartographic interaction by designing for anticipated user differences" (p. 75). ROTH (2013, p. 75) argues for three user characteristics affecting the quality of cartographic interactions: ability, expertise and motivation. Especially the user characteristic of motivation is of major importance, as it provides a natural link to one of the basic conceptual claims of gamification (see Ch. 3.4). For ROTH (2013, p. 78) designers should aim for motivating users in the phase of initial use and during the continued use of cartographic interfaces, as motivation "inspires users to overcome barriers to using a system", thus motivation is considered to be of greater importance for successful cartographic interaction than mere user expertise. Examples provided include offering of incentives, "demonstrating utility through real world examples" as well as to "reward positive interaction strategies" and "provide easy ways to correct mistakes" (p. 78). In contrast to earlier work, where motivation is considered mainly a static size, a kind of different motivational level of users which has to be considered in design through an optimal information-to-interface ratio, i.e. to design easy, not overloaded interfaces for users with little motivation (e.g. ROTH/HARROWER 2008, p. 58), to consider user motivation a dynamic size that has to be afforded throughout the interaction design of digital maps and interfaces falls very much in line with the conceptual claims of gamification: to design cartographic interaction with affordances for gameful experiences, as one possible path to take in a user-centered perspective considered with the user characteristic of motivation.

4.2.3 Narrative Cartographies and Story Maps

Narrative cartography constitutes a research field concerned with the "complex relationships between maps and narratives" (CAQUARD/CARTWRIGHT 2014, p. 101). From a cartographic point of view the authors differentiate conceptually between two perspectives on narratives and maps (p. 102):

- The first perspective, "*mapping stories*", is characterized by an attempt to "represent the spatial structures of stories", may they be oral, literary or audio-visual (ibid.). In this complex process of transforming stories into maps, the often fluid and non-continuous structure of space and time in narratives has to be broken down into spatiotemporal events to be representable in a cartographic sign system — a process leading to tensions "between the blurry personal, and emotional dimensions of stories and the characteristics of fixity, hierarchy and quantification inherent in conventional cartographic representations" (CAQUARD/DIMITROVAS 2017).

- Secondly, a perspective concerned with the "*narrative power of the map*" looks into the potential of maps to "tell and support" (CAQUARD/CARTWRIGHT 2014, p. 104) narratives as well as the narrative dimensions of mapping as an activity. The narrative potential of maps is used by writers to inspire and stimulate their novels or to "reveal all ranges of invisible geographic structures and patterns" (ibid.). Critical cartographies, on the other hand, "have exposed hidden and sometimes hideous, narratives and agendas embedded in maps, including their metanarratives" (CAQUARD 2013, p. 136), they looked for a "second text within the map" (HARLEY 1989). Arguably, in a more radical reading of critical cartography, one could add the perspective of "*maps as narratives*" to this typology, as HARLEY (1989, p. 281) and WOOD (1987, p. 27), among others, point out the textuality of maps. If maps are considered text, it is not only possible to argue for the "narrative qualities of cartographic representation" (HARLEY 1989, p. 281), but to treat maps themselves as narratives (CRAMPTON 2001, p. 240). In their analysis of a State Highway Map of North Carolina WOOD and

> FELS (1986) were inspired by BARTHES account of myths as (secondary) semiological systems (2015, p. 253). Such an approach enabled him to show how "objects were organized into meaningful relationships via narratives that expressed collective cultural values" (HUPPATZ 2011, p. 88). In post-representational cartography, where maps are conceptualized as never finished and perpetually in the process of becoming, the coming-to-life of a map depends on its different usage contexts and purposes (CAQUARD/CARTWRIGHT 2014, p. 104). The quality of a map therefore depends on "different narratives" associated with the map, that "describe its context of appearance, and its production process, as well as the discourses associated with the map, and the political and personal agendas it helped to push forward" (p. 105).

Gamification can be conceptually tied to the complex relationship between maps and narratives in a few possibles ways. First, narrative structures and stories are possible and wide used game design patterns serving the purpose of gameplay, as BJÖRK/HOLOPAINEN (2005, 216) point out:

> *"Having stories in games gives players both motivations for the existence of goals and challenges in the game and rewards for completing the goals by weaving the consequences of players' actions into an unfolding story".*

This entails a view of conceptualizing narrative structures as a sub-set of game design elements, thus being part of the notion of gamification as a design strategy. Therefore, all points of contact that can and have been established between cartography, GIScience and gamification arguably apply as well to narrative cartography in its "applied" form. Vice versa, narrative cartographies, due to their careful consideration between the relationship between narrative structures and maps, can inspire possible application scenarios for gamification. Starting from the endeavors of "mapping stories", possibly implemented via (interactive) multimedia web-applications like, for example, ESRI Story Maps (ESRI 2012[7]), the careful combination of narrative structures with other and related game design patterns may contribute to engage and motivate the user, which is consistent with the "elements" of user experience and interactivity in the design of story maps (cf. ESRI 2012, p. 5).

In a broader perspective, gamification could arguably be conceptualized as meta-narrative weaved into cartographic applications. As the "game logic" structures specific chains of action sequences towards a predefined goal or set of goals, gamification directs the interaction of the user with a cartographic interface. The interaction with an application for which, possibly, the user does not have a reason to, can be sparked by an interest or even pleasure in following or discovering an embedded meta-narrative. What WOODS (1987, p. 37) writes in the following about the indifference of users towards general reference atlases, can be addressed as problem of contemporary interactive web maps as well:

7 For an overview on contemporary online narrative cartography see CAQUARD/DIMITROVAS 2017

> *“’Why turn the page? It is bound to be just like the one before. North Dakota, South Dakota, France, Spain — what’s the difference?’ […] There is no reason to look at these products of imprisoned imaginations.”*

4.2.4 Emotional Cartographies

Several authors within the domain of cartography have put increasing emphasis on the relationship between emotions, affects and maps (e.g., GRIFFIN/MCQUOID 2012, CARTWRIGHT et al. 2008, AITKEN/CRAINE 2006). In this developing research field, the following perspectives can conceptually be differentiated.

A first perspective is concerned with the spatial representation of emotions and experience or the “*mapping” of emotions* (e.g. NOLD 2009, HAUTHAL/BURGHARDT 2013). This perspective is often accompanied by a conceptual call for considering the subjective quality of information and the representation of space as it is experienced by people (e.g., ITURRIOZ/WACHOWICZ 2010, p.88; GRIFFIN/MCQUOID 2012, p. 291).

Conceptually of greater interest with respect to this thesis is a perspective concerned with *“the emotions of map users”* (GRIFFIN/MCQUOID 2012, p. 292) or how people emotionally respond to certain map qualities, like for example color (FABRIKANT et al. 2012). Similar to approaches dealing with the rhetoricity of maps within critical cartography, although not focused on truth but emotional impact and persuasion, MUEHLENHAUS (2012) looked on different “rhetorical styles” of maps and how they “will impact the effectiveness of, and audience’s reaction to, the argument being presented” (p. 373). The effects of emotional responses on the persuasiveness of an argument are not only covered in traditional rhetorics but are tested within psychology (DESTENO et al. 2004). Map design informed by “theories and knowledge about emotion and affective responses” (GRIFFIN 2014) can build on the mentioned research and additional theories from design, especially emotional (NORMAN 2004) and persuasive design (WHALEN 2011), as well as film (AITKEN/CRAINE 2006).

It is within such a design-oriented perspective regarding the relationship between emotions and maps that gamification holds a possible point of contact: Game design in general and gamification in specific (see FULLERTON 2014, p. 12) aims for the design of gameful experiences, which in turn are carried mainly by emotions. A possible research agenda to be developed, keeping that relationship in mind, is to ask how gamified geo-applications can and should trigger emotions and how this adds up to a pleasurable experience (cf. NORMAN 2004) of the product. Furthermore, the development of a specific “rhetorical style”, as MUEHLENHAUS (2012) puts it, of gamified web-maps is conceivable.

4.2.5 Critical Cartographies

While multimedia cartography, as an application of existing cognitive and semiotic approaches in cartography to novel forms of visualizations utilizing different media (cf. PERKINS 2003, p. 343), is still clinging to the ideas of the representational character of cartography (see PETERSON 2007, p. 34) and its search for "ideal" methods of information and knowledge communication or transfer (see CARTWRIGHT/PETERSON 2007, p. 8), cybercartography pays at least a lip service to challenging "the false objectivity of maps" (TAYLOR 2005, p. 7 / CAQUARD/TAYLOR 2005) — a notion generally associated with the research approaches of critical cartography.

Critical cartography can be described as a body of work with a "more or less poststructuralistic and constructivist basic perspective" grounded in works by WOODS and HARLEY (MICHEL 2010, par. 14). For GLASZE (2009) critical cartographies are approaches starting with the rejection of the classic paradigm of cartography, the notion of maps as representation or picture of reality (p. 182, 187), and emphasizing one or both of the alternative paradigms of maps: maps as effects of social structure and producers of social realities (p. 187). Maps — *as effects of social structure* — reproduce the "rules of the social order", their "text is as much a commentary on the social structure of a particular nation or place as [they are] on its topography" (HARLEY 1989, p. 280). In an unconscious act of hierarchicalization of space (ibid.) cartographers reproduce social self-evidences (GLASZE 2009, p. 184), as HARLEY points out (1989, p. 280-281):

> *"The distinctions of class and power are engineered, reified and legitimated in the map by means of cartographic signs [...]. To those who have strength in the world shall be added strength in the map."*

Maps can be analyzed not only as mere effects of social structure but also *as producers of social realities*, as PICKLES (2004, p. 12 quoted in CRAMPTON/KRYGIER 2006, p. 15) argues:

> *"Instead of focusing on how we can map the subject...[we could] focus on the ways in which mapping and the cartographic gaze have coded subjects and produced identities."*

In contrast to the power *external to maps*, the power "exerted on cartography", where mapmakers were "responding to external needs" (HARLEY 1989, p. 287) and power exercised with cartography, a centralized and bureaucratically controlled undertaking "crucial to the maintenance of state power", there is also *internal power* to maps: their political effects. At the center of internal power stands "the cartographic process": for HARLEY, the compilation of maps, the selection of information, the generalization process and the rules for abstraction and hierarchicalization, the employment of rhetorical styles to represent the landscape is not a neutral process of catalogization, but one of appropriating, disciplining and normalizing the world (p. 287-288). However, these powers are not exercised in an intentional and unidirectional way (MOSE/STRÜVER, p. 317), the map acts more as “silent arbiter of power” (HARLEY 1989, p. 288).

Notably, HARLEY thinks of maps as graphic *texts* (HARLEY 1989, p. 281), which allows him not only to treat them as part of discoursive formations and complexes of power-knowledge (BORIS 2010, par. 16) in the spirit of FOUCAULT, but to point with DERRIDA toward the rhetoricity and narrative dimensions of maps. Not only is the cartographic process “inherently rhetorical” (HARLEY 1989, p. 285), as the map tries to “frame their message in the context of an audience” and “state an argument about the world” (ibid.), but to claim scientificity for maps, as an attempt to “pure itself of ambiguity and alternative possibility” (p. 284) and to “convert culture into nature” (p. 285), is itself a highly rhetorical endeavor.

CRAMPTON (2010, p. 17) suggests four basic principles in his textbook to order the diverse body of work subsumed under the term “critical cartography”. Similar to HARLEY, concepts associated with FOUCAULT take a more prominent role. Firstly, although affirming the power of maps to organize and create knowledge, their “orders of knowledge” contain unexamined assumptions which critical cartography tries to challenge. Secondly, these orders of knowledge are and have been challenged by taking a look from a historic, as well as a perspective across cultures and places. Thirdly, critical cartography emphasizes that geographic knowledge is formed by social, economic and historical forces and therefore exists only in relation to power: maps are political. Finally, critical cartography has an activist and emancipatory impetus, for example in showing the historical and spatial contingency of official state or government knowledges or in “dismantling” of more specific forms of knowledges like “recent work of feminists in critical GIS or community activism in participatory GIS”.

Apart from theoretical critique, critical cartography is also concerned with “new mapping practices” (CRAMPTON/KRYGIER 2006, p. 11) for which the “conceptual space” was now “cleared” (p. 17). These practices, realized mostly outside the academic field, encompass diverse undertakings such as “map experimentation by the artistic community” (ibid.), imposing a challenge to “received notions of space, knowledge and power” (p. 25); a “by-passing” of the “disciplinary avenues of academic expertise and control” (p. 18) to make mapping tools available more directly, leading to a “people’s geography” utilizing open-source mapping capabilities, for example through the practice of “map hacking”; mapping as a form of resistance against “space represented by official state agencies” to provide “alternative mappings” in the form of so-called “counter-mappings” or via (public) participatory GIS (p. 25) as well as so-called “everyday mappings”, which “creatively illuminat[e] the role of space in people’s lives by countering generalized and global perspectives” (ibid.).

Within such a diverse body of work many theoretical ties and justifications for the use of game design elements seem to be possible, although such points of contact are not explicit ones. If, however, gamification is conceptualized mainly as design strategy, a view emphasized in this thesis, critical cartography’s agenda and focus on alternative mapping practices provide inspiration and goals for the design of gamified mapping applications: engaging users in applications designed to empower the user to experiment with maps, to provide "alternative mappings" within a "people's geography" and at the same time raise awareness for the inherently political and rhetorical practice the user is engaged in — overcoming the traditional notion of maps as picture of reality and its scientific rhetoric. Furthermore, critical cartography can be described as ground-breaker for the endeavors of post-representational cartography (see Ch. 4.2.6).

4.2.6 Post-representational Cartography and Ludic Mapping Practices

Post-representational cartography can be described as part of critical or postmodern cartography (cf. FERNÁNDEZ/BUCHROITHNER 2014, p. 89). However, similar to traditional cartography, where maps were conceived as objective truths or representations of reality (see Ch. 4.2.5), postmodern cartographies, although describing maps ontologically as social constructions, still "conceive maps as inherent truths" and do not challenge the ontological status of maps (ibid., p. 88). In contrast, post-representational cartography tries to "rethink" (KITCHIN/DODGE 2007) cartography's ontological and epistemological base: Rather than focus on the notion of a coherent stable map — although possibly conceptualized as having effects in the world, such as producing social realities —, a performative and ontogenetic understanding of maps (FERNÁNDEZ/BUCHROITHNER 2014, p. 97) is envisaged. As KITCHIN and DODGE (2007, p. 340) put it:

> *"Maps emerge in process through a diverse set of practices. Given that practices are an ongoing series of events, it follows that maps are constantly in a state of becoming; they are ontogenetic (emergent) in nature. Maps have no ontological security, they are of-the-moment; transitory, fleeting, contingent, relational and context-dependent. They are never fully formed and their work is never complete. Maps are profitably theorized, not as mirrors of nature (as objective and essential truths) or as socially constructed representations, but as emergent."*

In this processual view of cartography maps do only exist in practice, as "the map happens or occurs only when someone interprets a given visual form, so it is always practical" (FERNÁNDEZ/BUCHROITHNER 2014, p. 98).

Similar to critical cartography, but from a different ontological perspective, post-representational cartography is also interested in *everyday* mapping practices (MICHEL, par. 36). It is against this background that PERKINS (2009, 2013) argues to rethink mapping as "playful", as opposed to make and use maps only for an instrumental task. The author shows how map-making, map use and map publication "call particular playful encounters with the world into being" (ibid., 2013). In line with post-representational cartography, PERKINS (2013) focuses on the process of mapping, rather than an ontologically fixed map, and on, although very specific, (social) contexts in which this process performs: play. It is due to his metaphorical and arguably puffed out use of the term “play” and “playful” that PERKINS (2013) can describe different practices associated with the mapping process as “playful”. However, this analysis of play, considering CALLOIS’ (2001) distinction between paidia and ludus (see. Ch. 2.1), is more oriented towards the paidia pole. Apart from these often implicit practices, PERKINS (2009, 2013) further analyzes more structured and rule-based forms of play with mapping, i.e. video games. In these games “the act of mapping […] is itself carried out as a central part of the simulated game”, as the players “are literally playing with the maps” (2009, p. 176).

It is with such a theoretical lens that gamification can be described as a more restrained, structured and explicit form of a “ludic approach” to mapping: a form more oriented towards the ludus pole, but with specific design and interaction goals, as well as non-game contexts in mind (as opposed to video games); a form explicitly designed to afford or evoke gameful experiences, to explicitly mingle gameful everyday practices with an mapping application (in contrast to implicit and already happening playing with maps and mapping in everyday practices). Furthermore, if the map exists only in practice and not as a stable artifact (cf. FERNÁNDEZ/BUCHROITHNER 2014, p. 98), and the practices and contexts of a geospatial application arguably change through gamification, gamification itself proves not only an addition or enhancing of a fixed “core” service, but an ongoing altering of “the” core map service altogether.

4.3 Potential of Gamification and Possible Research Agendas

In the following, out of a synthesis of previously discussed possible points of contacts with established concepts and research topics in cartography and GIScience, the potential of gamification as well as future research agendas within the respective fields will be discussed. Therefore an attempt is made to provide an answer to the remaining part of the first research question as well as to the first part of the second question.

As it was shown, the concepts of *cybercartography* and *multimedia cartography* provide theoretical connections with gamification in their emphasis on finding new ways of user engagement and interactivity, as well as on a conceptual call for using multimedia elements, respectively. This falls in line with the research field of *cartographic interactivity and interface design*, as a user-centered design process concerned with the user characteristic of motivation is arguably very close to gamification’s conceptual claims. Out of the interrelation of multimedia, interactivity and new ways of user engagement the following research agendas may be derived: First, a need to explore how cartographic interfaces, interactivity and multimedia applications may benefit from the use of game design elements. Such an agenda may incorporate findings and application design strategies from specific cartographic applications, e.g., within the domain of crowdsourcing (e.g., MORSCHHEUSER et al. 2017) as well as “geogame”-designs (see Ch. 4.1). Furthermore, focusing on cartographic interaction design, the successful linking of game patterns with cartographic interaction primitives (e.g., ROTH 2012) in relation to affordance of user motivation provides a rich field of exploration.

Additionally, as the analysis of the concepts of *narrative and emotional cartography* has demonstrated, the design for pleasurable experience or emotional design has found its way into cartography and GIScience. Moreover, the use of narrative structures as a special type of game pattern, is, as the spreading of online multimedia "story maps" shows, on the rise. Not only provide narratives affordances for pleasurable experiences, but they also play a tremendous role in terms of user persuasion. Within this interrelated complex of emotion, narratives and persuasion the following research agendas are proposed: First, one approach may focus on actual narrative online or story maps, and try to enrich these applications with other game design patterns. This approach is in accordance with the general quest for meaningfully enrichment of geo-spatial applications with game patterns outlined in the last paragraph. However, the specific relation between maps, narratives and other game elements is still the key area of interest. Besides, the use of narrative structures and other game design elements in geo-spatial applications has to be questioned regarding the role these elements can and should play in the triggering of emotions or emotive states with respect to designing these applications for a pleasurable product experience. Finally, the potential of game patterns in relation to user persuasion can be subject of further examination.

Concept	Possible Point(s) of Contact / (Application) Potential	Possible Research Agenda(s)
Cybercartography	New way of user engagement; interactivity	- How can cartographic interfaces, interactivity and multimedia applications benefit from the use of game design elements in an user-centered design process? - How can specific game patterns be linked to cartographic interaction (primitives) with respect to affording user motivation?
Multimedia Cartography	Use of multimedia	
Cartographic Interactivity and Interface Design	User-centered interface and interaction design (user characteristic of motivation)	
Narrative Cartography	Narrative structures as game design patterns; pleasure; story maps (user experience and interaction design)	- How can narrative online or story maps be prolifically enriched with other game design patterns? - How can and should narrative structures and other game design elements in geo-spatial applications trigger emotions and how does this result in a pleasurable product experience? - Which role can game design elements in geo-spatial application play regarding user persuasion?
Emotional Cartographies	emotional design; design for pleasurable experiences; persuasion and rhetorical style	
Critical Cartographies	new mapping practices; empowerment	- How can game design elements be used with respect to the agendas of critical cartographies (e.g., empowerment, critique of scientific rhetorics and of maps as neutral representation)? - How can the analysis of gameful mapping practices contribute to a richer understanding of maps and how do these practices change maps themselves?
Post-representational Cartography and ludic mapping practices	gameful mapping practices; altering of map itself	

Table 7: Possible points of contact and research agendas with respect to selected concepts in cartography and GIScience (own work)

Critical and post-representational cartographies provide a different ontological understanding of maps and mapping practices. The social context of maps and their relation to spatial knowledge production are at the center of interest. With a broader understanding of mapping, a critique of the traditional representational paradigm as well as an interest in "alternative mappings" and their emancipatory potential, these concepts may inspire quite different research agendas as the ones outlined before: First, game design elements may be questioned regarding their potential to be utilized for the agendas of critical cartographies (e.g., regarding their emancipatory or empowering potential or their potential to explicate the tacit presuppositions of scientific cartography). Additionally, an analysis of gameful mapping practices may contribute to a richer understanding of maps and mappings, also in relation to their design to afford these practices. From a post-representational cartography's point of view it would be profitable to ask how gameful mapping practices change "maps" themselves, as these practices often defy any instrumental use of maps or mapping applications.

4.4 A User-Centered Framework for Geo-Gamification Design

In the following a framework for geo-gamification design, combining user-centered design (UCD), existing general gamification frameworks (see Ch. 3.7), game design literature, theoretical reflections outlined in the previous chapters (4.1. - 4.3), as well as (cartographic) interaction design, is developed. Such a comprehensive approach has not only the advantage of providing a framework centered at geospatial applications but also of compensating blindspots of the respective partial fields. The framework or conceptual model for geo-gamification design refrains from a formalistic understanding of the gamification design process for the following reasons: First, game design patterns can not, or only in a very basal degree, be formalized (see Ch. 3.5.2). Secondly, a formalistic understanding of the design process would restrict creativity in design as well as flexible adaption to processes or functionalities of an application. Finally, game design patterns exhibit characteristics of design strategies or guidelines, and as such may be more easily integrated in a conceptual model than a rigorously formalized framework or software library.

User-centered design, as specified in the International Usability Standard (ISO) 13407 (Human-centered design processes for interactive systems), is concerned (cf. HHS 2018) with a design process based on an explicit knowledge about the users of the product, the requirements of their tasks as well as of the surrounding environments. Characteristically is furthermore an involvement of the users throughout the iterative design and development process, which in term is guided and refined by empirical user evaluation. Additionally, the design should address the whole user experience, i.e. impressions a user experiences during the use of a product (cf. GARRETT 2011, p. 6). Finally, the design team should include multi-disciplinary abilities and points of views (cf. HHS 2018).

In the *cartographic reception*, the conceptual call for user-centered design is most prominently traced back to cognitive and usability issues as specific research challenges within (but not limited to) the domain of geovisualization (e.g., ROBINSON et al. 2005, p. 244/NIVALA et al. 2005, p. 109). In their paper "*Research Challenges in Geovisualization*" MACEACHREN and KRAAK (2001, p. 8) argue for the development of a "comprehensive user-centered design approach to geovisualization usability", as there is a "current lack of established paradigms for conducting cognitive and usability studies with highly interactive visual environments". Since the release of the article by MACEACHREN/KRAAK (2001), several authors developed user-centered design frameworks for their special areas of interest[8], more or less based on the framework for the implementation of user-centered design application outlined in the ISO Standard 13407. The framework developed in this section is inspired by one of these frameworks, more specifically, by TSOU and CURRAN's (2008) "*Five-Stage User centered Design Framework for Web-based Mapping Application*", which in turn is based on the general framework for user-centered design, outlined by GARRETT (2011) in his book "*The Elements of User Experience: User-centered Design for the Web and Beyond*".

User-centered design has also been taken up explicitly by *gamification and serious game literature and theory*. For example did NICHOLSON (2012) develop an "user-centered theoretical framework for meaningful gamification" (see. Ch. 3.7) and the main or development phase of serious games arguably follows a user-centered design approach (e.g. DÖRNER et al. 2016, p. 15). Also, if the improvement of (playful) user experiences are a key focus or goal in gamification design (e.g. DETERDING et al. 2011, p. 12), a user-centered design approach arguably serves at least the implicit conceptual foundation for every gamification framework.

The framework developed here will follow GARRETT's (2011. p. 20) five progressive stages or planes. The stages show, from strategy to surface, a decreasing level of abstraction or an increasing level of detail, respectively (p. 21). Due to the progressive nature of the framework, design decisions made on a more abstract plane influence those on more concrete planes (p. 22). However, decisions or problems encountered on a more concrete plane can lead to an adaption or reevaluation of more abstract planes, so dependencies between the planes exist in two directions (p. 24). Furthermore, in contrast to the ISO 13407 framework (cf. TSOU/CURRAN 2008, p. 313), there is no need to finish each stage sequentially, as their development can partly overlap (GARRETT 2011, p. 24). Additionally, the framework, initially developed for the design and implementations of web pages, takes also the basic duality of modern interactive mapping applications into account (p. 27): the duality between the *product as platform of functionality* — a view of the product as tool or tool set provided to the user to fulfill specific tasks (p. 28) — and the *product as medium of information* — the "information the product offers and what it means to the users" (p. 28). As gamification is the main goal of the framework, to complement this duality, another component is integrated into this framework: the *product as affordance for gameful experiences* (in the following briefly called "ludic affordance"), the gameful experience the product may offer the user, arguably extending this duality into a triplicity. The advantage that adding this analytical separation in the framework — in contrast to reduce, for example, ludic affordances to game mechanics and thus being subject solely to interaction design, is to allow for analysis and conceptualization of the relationships between the three parts at each stage or plane and how ludic affordances may

8 E.g., Geovisualization Tools for Epidemiology (ROBINSON et al. 2005), Mobile Map Services (NIVALA et al. 2005), or Web Mapping Applications (TSOU/CURRAN 2008), or multimedia cartography (VAN ELZAKKER/ WEALANDS 2007).

be designed across all levels of abstraction the framework provides. Furthermore, it accounts for the case that gamification is used to improve an already existing application or service. In that case, the framework helps to possibly revise certain aspects of the application design on different levels of abstraction in order to provide affordances for gameful experiences that have been considered already in the development of the strategy of a product and not just “put on top” of an existing application. Nonetheless, this component or view, in contrast to the two existing ones, has a stronger relational character, mirroring the conception of gamification as the use of affordances for gameful experiences in (pre-existing) non-game contexts.

<table>
<tr><th></th><th>Product as Information</th><th>Product as Functionality</th><th>Product as Ludic Affordance</th></tr>
<tr><th rowspan="2">Strategy</th><td colspan="2">Product Objectives</td><td rowspan="2">Gamification Concept</td></tr>
<tr><td colspan="2">User Needs</td></tr>
<tr><th>Scope</th><td>Content Requirements</td><td>Functional Specifications</td><td>Gamification Mechanics</td></tr>
<tr><th>Structure</th><td>Information Architecture</td><td colspan="2">(Game) Interaction Design</td></tr>
<tr><th rowspan="2">Skeleton</th><td>Navigation Design</td><td colspan="2">(Ludic) Interface Design</td></tr>
<tr><td colspan="3">Information Design</td></tr>
<tr><th>Surface</th><td colspan="3">Sensory Design</td></tr>
</table>

Table 8: Conceptual framework for the design of gamified geo-applications (Based on GARRETT 2011) (Note: The dashed lines denote strong interdependency)

4.4.1 Strategy

On the *strategy plane* the basic strategic objectives of the application or service are defined. Both, from a functionality-, and from an information-based view, user needs and product objectives are subject to strategic planning (GARRETT 2011, p. 28). Additionally, the role of ludic affordances with respect to product objectives and user requirements has to be considered in the development of a gamification concept. It is advised to define product objectives and user needs in a formal strategy document (p. 53-54).

Product objectives encompass questions regarding the objectives imposed on the product or service from inside the organization that develops the respective product or service (p. 36). These may be business related and formulated as business goals (p. 37) and, additionally, be influenced by the amount of resources (time, money, employees, technical infrastructure) and know-how (cf. NIVALA et al. 2005, p. 111) the organization is capable or willing to make available for the product or service.

User needs, on the other hand, encompass the goals or needs users have regarding the product or service (GARRETT 2011, p. 28). In order to understand which goals, needs or requirements the users have, it is necessary to get to know the user (p. 46). This process of user research can differentiated into two components (cf. VAN ELZAKKER/WEALANDS 2007, p. 491): first, the *definition* of the population of users regarding their demographics, skills and abilities as well as psychological characteristics such as attitudes, motivations and preferences and secondly, to get an *understanding* about the user goals, tasks and requirements regarding the product or service as well as information in relation to these goals, tasks and requirements (e.g., attitudes of users regarding their tasks, possible environmental and situational influences, problems and attitudes towards specific interface designs and technology in general). However, often a clear definition of goals and users is problematic due to the nature of certain applications or services, for example, exploratory geovisualizations (cf. SLOCUM et al. 2001, p. 71) or ipso facto poorly definable (cf. ROTH 2012, p. 380). In that case, a top-down approach, deriving goals from general taxonomies or lists (e.g., DIBIASE's (1990) swoopy diagram[9]) or existing domain-specific classifications (e.g., JAKOBSSON 2002 for location-based services) may be beneficial.

After gamification has been declared compatible with general business operations[10], the strategic objectives of employing gamification for the product have to be established. Such a *gamification concept* provides a general conceptual model on how the design for gameful affordances supports both user needs and product objectives. Depending on the level of detail in the specification of goals and tasks the application has to support, the concept may provide a more or less clearly articulated mapping of ludic affordances to specific tasks and goals of the application. Nonetheless, clear ludic experience goals should be defined and linked to product objectives and user needs. These experience goals may be conceptualized as outlined in the playcentric design process by FULLERTON (2014, p. 15) (see Ch. 3.5.5).

The gamification concept is therefore not to be developed separately, but is strongly influenced by the defined product objectives for the application that is about to be developed. For example, is the goal to continuously engage users in using the products or services or should it help to encourage a (one-time) deeper exploration of the product or service? Should gamification provide new usage contexts and independent value propositions for a service or product (cf. BLOHM/LEIMEISTER 2013, p. 277) or motivate users to engage in existing usage contexts? Furthermore, the complexity of the product or service influences the overall gamification strategy. As evidence suggests, easy and repeatable tasks may benefit more from a simpler, i.e., pointsified, approach to gamification (cf. MORSCHHEUSER et al. 2017). If the core service or product already exists and gamification is planned as an enhancement of the product, the analysis of existing usage patterns and individual user motives (cf. BLOHM/LEIMEISTER 2013, p. 276) provides an excellent starting point for defining a gamification strategy. Ideally, as with business goals, success metrics help to determine when and whether the product objectives have been met (GARRETT 2011. p. 39). With respect to gamification such

9 DIBIASE (1990) outlines four such goals (cf. ROTH 2013, p. 68): exploration, confirmation, synthesis and presentation.

10 A general, but often not realistic assumption of this framework, as gamification may undermine established business practices (e.g. BOGOST 2011a, 2011b see Ch. 3.8.1) and may be a risky and expensive task with respect to its development efforts and hard to measure and guarantee of effects (cf. HERZIG et al. 2015, p. 431).

indicators could encompass certain engagement criteria or success rates, e.g., 50 percent higher user retention (cf. HERZIG et al. 2015, p. 434).

4.4.2 Scope

On the scope plane the defined strategy is translated into functional specifications, if the product is regarded as functionality, or into content requirements, if it is regarded as information (GARRETT 2011, p. 29). *Functional specifications* are basically a detailed description of the features the product or service should provide[11] in order to meet user needs and product objectives (p. 29), whereas *content requirements* provide a description of the content elements needed for the product or service (p. 29). Often this process may include the selection or development of an appropriate content management system (p. 64). Content and functionality requirements often have an impact on each other (p. 63) and can be addressed in similar way as requirements of *features* (p. 62). The definition of these requirements may vary regarding their level of detail depending on the complexity of the product (p. 65). Apart from user research, the analysis of competing products or services with similar product objectives may be beneficial for the definition of requirements (p. 67). Furthermore, a clear mapping between strategic objectives and requirements helps to prioritize requirements (p. 77) in order to determine the core features of the product or service.

Based on the gamification concept, core *game mechanics* supporting the set ludic experience goals are chosen. This step does not exactly map onto GARRETT'S (2011) framework, as game mechanics or concepts may have to be defined already (although possibly not in that great a detail) in the strategy plane to provide a clear mapping between user goals and tasks and ludic affordances. Furthermore, game mechanics may need specific game features (content and functionality) independent of the core product or service to work, although game mechanics, in order to support the user needs and goals, should arguably mainly draw on the content and functionality required for the core service or product. Although, in term for game mechanics to work, certain mechanics may lead to a necessary redefinition or change of general feature requirements.

4.4.3 Structure

After defining and prioritizing the requirements of the product it is necessary to provide a conceptual structure of how these requirements work together as a coherent whole (GARRETT 2011, p. 79). On the structure level the designer deals with *interaction design* (in terms of functionality) and *information architecture* (in terms of information). Both are concerned with the definition of structured sequences of options presented to the users. These options may be related either to the performing and completing of tasks (in case of

11 E.g., "interactive map manipulation, querying attributes from water quality monitoring sites, and downloading GIS data." (TSOU/CURRAN 2008)

interaction design) or the transport of information to the users (in case of information architecture) (GARRETT 2011, p. 81). The best way to document the developed interaction design and information architecture is through an (architecture) diagram in which the branches, groups and interrelationships between application components are visually depicted and easy to communicate (p. 101).

As outlined in chapter 4.2.2 (cartographic) *interaction* can be defined as a "dialogue between a human and a map mediated through a computing device", where human and map are considered to have "the ability to affect change on the other" (ROTH 2013, p. 64). A single interaction exchange in an overall interaction conversation between human and map-interface can be described in a general model as a sequence of seven observable steps. The model proposed by ROTH (2012) is based on NORMAN´S (2013, p. 40) stages of action model. In contrast to most existing interaction workflow models agency is not only assigned to the human part of the interaction, but provides a two-way conversation metaphor of interaction which describes an interaction exchange as the alternation of a sequence of execution (dialogue of user to map) and evaluation (dialogue from map to user) (ROTH 2012, p. 379). Although simplified, the model provides a framework to understand human action as well as guiding interaction design (NORMAN 2013, p. 42). The seven steps of interaction include (ROTH 2012, p. 380):

1. *Forming the Goal:* The goal states what the user tries to accomplish. Goals may not only be often hard to define but can be subconscious as well (NORMAN 2013, p. 42). They can be nested or hierarchically structured, which means that goals may be subgoals or intermediate goals to other (overarching) goals. As most goals may not be achieved in only one interaction exchange, multiple loops of all stages of interaction have to be cycled to achieve the goal and the respective subgoals. In the outlined design process user goals are ideally acquired in the strategy plane via user research, derived out of existing taxonomies or through analysis of existing applications within the same application domain (i.e., best-practice examples).

2. *Forming the Intention*: The intention, specified out of the broader goals, corresponds with the task or *objective* the user wants to complete. NORMAN (2013, p. 41) refers to this stage also as planning stage, as the user chooses out of many possible plans of action one that may lead to achieving the goal. Similar to goals, tasks may be dependent on past interaction sequences. Additionally, if only a vague notion of a goal exists (e.g., with exploration-type applications), no clear plan or objective may be present in the beginning of the interaction sequence. As with goals, possible user tasks should be explored in the strategy plane via user research or derived from general or purpose-driven objective-based taxonomies (ROTH 2012, p. 384).

3. *Specifying an Action*: After the objective or plan has been conceived, the user has to specify how to perform the respective objective or plan (NORMAN 2013, p. 40). To this end, the user assigns his or her objective or task to certain *operators*, or, in case of interactive applications, to "functions provided by the cartographic interface

that are perceived by the user to support this objective" (ROTH 2012, p. 380). As with goals and tasks, cartographic interaction literature provides existing operator-based taxonomies. In the present design framework, functional specifications are outlined at the scope level.

4. *Executing the Action*: The user now has to "do" the action. He or she executes the identified operator. The object with which the user interacts directly or indirectly — the *operand* or operator recipient — is in cartographic interaction design a digital map (component) or information linked to the map. The user manipulates the cartographic interface through a pointing device or other input device.

5. *Perceiving the State of the System*: Through execution of the operator the system state changes and the evaluation sequence starts. The operand has now to signal the user what has happened to it — the operand provides feedback to the user. Through provision of feedback, the operand takes part in the human-map conversation.

6. *Interpreting the State of the System*: The user now has to make sense of the perceived update of the operand. Again, the operand provides information about the impact of the action in an easy interpretable form (NORMAN 2013, p. 72).

7. *Evaluating the Outcome*: The user now has to compare the interpreted outcome with the required result, both in terms of the validity of the outcome and regarding its role in achieving the goal the user tries to accomplish. The evaluation can return a negative result and lead to another interaction exchange.

Importantly, the cycle has not to start at stage 1 by setting a goal (goal-driven behavior), but can also be initiated by some event triggered by the operand or digital map (data- or event-driven behavior) at stage 5 (NORMAN 2013, p. 42-43).

Of crucial importance in interaction design are conceptual models, mostly simplified explanations of "how something works" (NORMAN 2013, p. 25). They provide understanding, enable the user to predict how the product or service will behave in response to certain actions and help in case of an unexpected result (p. 28). Ideally, a conceptual model should be intuitively grasped by the user and not have to be explicitly communicated, which may confuse the user (GARRETT 2011, p. 84). Conventions govern the existence of conceptual models in certain application domains, that is why user research may provide useful knowledge about existing conventions regarding conceptual models. Conceptual models further influence the interface language and components (p. 83). With respect to the interaction model proposed above, conceptual models support the user to form a plan or objective (step 3), as the conceptual model provides a pivotal link in the translation process between the objective and the necessary operator. They play a crucial role in the execution of an action (step 4), as the user has to know how the operator can be applied to the operand. Furthermore, the conceptual model helps in understanding and evaluating the result (step 6 and 7), as it provides the user with an idea on how the result should look like based on similar experiences. Game mechanics or concepts, if they are well-known, may also serve as conceptual models for interaction exchange, as they provide known interaction sequences.

The structure component with respect to content is concerned with *information architecture* or the creation of "organizational and navigational schemes that allow users to move through site content efficiently and effectively" (GARRETT 2011, p. 89). The development of categorization schemes which match the product objectives, user needs, and the integrated content is a central task in information architecture (p. 89). Basically two approaches to the creation of categorization schemes can be distinguished. A top-down approach derives the architecture directly from strategic goals, whereas a bottom-up approach extracts its categories and subcategories through an analysis of the content and functional requirements defined at the scope plane (p. 90). Conceptually, the selected units of information, may they be numbers or entire pages, can be conceived as nodes which can be arranged in many ways (p. 93). The specific node arrangement, may it be hierarchical (tree-form), in matrix form, organic or linear, allows the user to move from node to node in different ways, leading to an alternative user experience each time (p. 94).

Game design is arguably closely related to interaction design as the main objective in game design is to design *interaction* in games (cf. BJÖRK/HOLOPAINEN 2005, p. 33). Considerations regarding the general interaction design on the structure stage apply therefore for ludic affordances as well, but the role of game components in single or a series of interaction exchanges has to be kept in mind. It is therefore first necessary to clarify — with the help of the gamification concept defined in the strategy plane — if an individual interaction exchange can or should take place independently of specific game components. Fundamental aspects regarding the role of game components in an interaction exchange in need of taken into consideration may be grouped by the objective, the operator, as well as the operand of an interaction exchange.

The *objective* or task the user wishes to complete in an interaction exchange is, as stated above, derived out of the general goal the user pursues. It is therefore necessary first to clarify how the defined gamification strategy is intended to or actually does influence the user goal and objective in a single interaction exchange (sequence). Do game mechanics provide additional goal structures? If so, how do game-related goals relate to non-game goals and how are they affecting user objectives and motivation? Are the rules imposed by the game mechanics "complicating" the actual non-game-related task achievement as it is arguably characteristic to games (see SUITES (1978) in Ch. 2.1) or just provide a semanticization (see Ch. 4.2.3) of the tasks through an extra, and possibly optional, task layer?

Depending on the degree the tasks the user wishes to complete are mingled with the game mechanic, the *operator* the user chooses, may contribute to fulfill only the game-related or the non-game-related side of the task, or both at once. As defined in the scope plane, additional game-related functional requirements may be necessary in addition to the general functional specifications in order for the game mechanics to work.

With respect to the *operand* — the operator recipient — its role as "genuine" map object or additional game component, or possibly both at once has to be considered. Furthermore, the operand takes part in the human-map dialogue through provision of feedback. So even if in a singular interaction exchange only game mechanics working with game-related functions on game-components (e.g., objects placed on or unrelated to the map or its components) are included, the operand may provide (through the provision of feedback) external drivers that influence or even created new goals and tasks for the ongoing interaction session. NORMAN (2013, p. 43) refers to behavior that takes advantage of circumstances as “opportunistic”. It makes sense to comprehend such game-event triggered behavior as opportunistic behavior intended by the designer of gameful affordances. Moreover, the provision of feedback is not only considered a central characteristic of every game (e.g. MCGONIGAL 2011, p. 21), but a major contributor of game experience as well (see Ch. 3.4.4).

4.4.4 Skeleton

On the skeleton level the conceptual structure is further refined through consideration of individual components and their relationships (GARRETT 2011, p. 107-108). If the product is viewed from a functionality perspective, the skeleton plane is concerned with *interface design*, whereas from an information-based perspective *navigation design* is the key focus point. Additionally, relevant for both views is *information design* (p. 108).

Interface Design is concerned with the selection and arrangement of interface elements with respect to the tasks the user tries to accomplish, in an easily understandable and usable manner (p. 114). In the terminology developed in chapter 4.4.3, interface design is focused on the operator-operand relationship in cartographic interaction design. In (web) mapping applications, the arrangement and grouping of different mapping functions (e.g., zoom, pan, rotate, query, identify, show attributes) and other map elements (e.g., multimedia graphics, graphs and legends) in windows is part of interface design (cf. TSOU/CURRAN 2008, p. 314 / MUEHLENHAUS 2014). Again, due to the notion of game design as design for interaction in games outlined in chapter 4.4.3, interface design overlaps with *game* interface design, as the operators and operands may be game-related to varying degrees and as such entail specific game interface elements and patterns such as points, badges and leaderboards (see Ch. 3.5.1).

Navigation Design also deals with the design of interface elements, but with a focus on how these elements facilitate the movement of the user through the information architecture as defined in the structure plane (GARRETT 2008, p. 108). As such, navigation design has to fulfill three goals at once (p. 118-119): to enable the user to get from one unit of information[12] to another; to communicate the relationships between units of information it includes; as well as to communicate the relationship between the unit of information the user is examining and the contents of the product. In geospatial applications the (interactive) map serves as a powerful navigation metaphor, arguably having the potential to contribute in fulfilling the outlined goals of navigation design.

12 As defined in the structure plane (Ch. 4.4.3), an information unit can be as diverse as a single page or a number.

However, navigation design has to consider the role of additional information units in other map-related elements such as graphs and legends linked to the map view, as well as navigational issues regarding different map base and thematic layers (not to mention applications going beyond a simple single map interface design).

Information Design consists in the design of information to facilitate user understanding. It involves questions regarding adequate (visual) presentation of data, grouping and comprehensible arranging of information, as well as helpful feedback to support user tasks and goals (p. 124-126).

The layout of the application or web page can be represented in a page schematic or *wireframe* (p. 128). This document incorporates interface, navigation and information design, as it depicts the arrangement and definition of interface, navigational and informational elements, as well as laying the foundation for the surface design (p. 131).

4.4.5 Surface

The surface level is primarily concerned with the sensory design of the arrangement decisions taken at the skeleton level (GARRETT 2008, p. 134). Though the design of a product has to consider all senses, traditionally, maps and interactive mapping applications were primarily concerned with visual design[13], hence the emphasis put on use of color, typography and visual variables in cartographic communication (e.g., ROBINSON 1995, MUEHLENHAUS 2014). From a game design perspective, aesthetics play a crucial role in facilitating the intended game experience and atmosphere, as well as supporting game mechanics through adding “pleasure of sensations” (SCHELL 2005, p. 385). The design decisions made, from color palettes, typography standards to individual interface and navigation elements is documented in a style guide (GARRETT 2008, p. 151).

13 However, the multisensory presentation of geographic information has been and still is a point of research in recent research in cartography and GIScience (see Ch. 4.2.1).

5 Atlas of Philosophical History Prototype

5.1 Concept and Design

5.1.1 Background and Contextualization

After outlining the potential of the gamification concept for the use and enhancement of (geo-)applications, the review and synthesis of theoretical work within the field of discourse, a framework for the design of gamified geo-applications, extending an existing one, was created. Now the developed framework as well as the delineated theoretical points of contact are used to inform and guide the design process of a gamified web-mapping application, in order to answer the second part of the second posed research question.

The application aims to contribute — in the limited context of a master thesis — in overcoming the diagnosed duplexity of limitation in the field of discourse (see Ch. 4.1.4), in the following way: Practical limitations to crowdsourcing and VGI are loosened by providing a use case in the more ubiquitous context of (explorative) web mapping applications. Hopefully, within a more general setting the application may contribute to the overcoming of methodological limitations regarding the design of gameful affordances, as the design strategy attempts to closely tie gameful affordances to application goals and tasks — while at the same time going beyond a pointsification-approach to gamification.

Although, arguably not relevant for the goals of this thesis, the theme of the application influences both its design strategy and its surface appearance, therefore a short contextualization as well as hint to similar products is necessary. To the knowledge of the author of the thesis, no comprehensive atlas or map-based interactive explorer of the history of philosophy exists, thus the application may even provide a new thematic background as a web-mapping application. Similar products are graph-based visualizations (e.g., see FISHER 2013) or atlases in bound form (e.g., see HOLENSTEIN 2004).

5.1.2 Strategy

The *product objectives* for the application define as primary goal the development of a gamified web mapping application that should provide users interested in philosophy and the history of philosophy with an interactive tool for spatial exploration of a geo-coded data set of philosophers. The application should be free and easy to use as well as enjoyable. *Restrictions* exist mainly regarding the use of open-source software and freely available data, more specifically the DBpedia database, as well as know-how and developing time, as the application is created within the bounds of a master thesis. As both time and know-how is restricted, the use of or development of game engines as well as the use of additional data only relevant for game mechanics should be avoided. It is not expected for the development to go beyond a working prototype at this time.

As restrictions regarding development time and human resources exist, as well as no clear user group or population is a priori definable, *user needs* have to be derived from general taxonomies as well as from plausible assumptions regarding possible user groups. At a base-level, DIBIASE'S (1990) swoopy diagram will be used to classify the application as primary serving the purpose or user goal of *exploration*: the multi-perspective inspection of information in order to gather unknown insights or create new hypotheses about the studied content. Besides exploration, leisure and pastime are assumed to be important user goals because of the non-productive nature of the application and its possible irrelevance in everyday life. The following assumptions regarding the user population will inform the development of the application: a medium to high interest in the content of the application, i.e. philosophy and the history of philosophy, a base-level knowledge of the content and low to medium proficiency in using web-mapping applications in general.

Ludic affordances built into the application should primarily serve the main product objectives, while attempting to engage the user in the core functionality as well as support the exploration of new or not anticipated usage contexts. Due to the non-linear nature of explorative applications, the *gamification concept* advises the use of ludic affordances in a way that guides (but not prescribes) the gathering of new insights while being enjoyable at the same time. The user has to be in control, so the use or even confrontation with ludic affordances should be optional. The main ludic experience goal for the user is to provide a sense of exploration and challenge in an enjoyable, non-competitive and non-stressful environment, as constraint and stress would undermine the user goal of free and multi-perspective inspection of information. A clear mapping of user tasks or application functionality to gameful affordances, expressed in the form of mechanics, will be outlined in the scope and structure level, as feature functionality and user tasks are defined there. From the use of a formalized strategy document will be refrained, since the application is developed by one person and no communication between different stakeholders during the development process is necessary.

5.1.3 Scope

The application should provide the following functionality (i.e. the *functional specification*), serving the user goal of exploration as defined in the previous sub-chapter:

- Interactive and map-based selection and query functionality for philosophers and their attributes
- Basic functionality for interactive map manipulation like zooming, panning, geocoding and switching between different map base layers

- Functions to filter for attributes and combinations of attributes
- Interactive and animated time line
- Bookmark system to save features for later reference
- Interactive graphs to query and filter the data set
- Interactive tutorial to acquaint the user with the core functionality of the application

From an information-based view the following *content requirements* have to be met:

- A data set of geocoded philosophers with all attributes necessary to support the filter and query functionality, depicted in the form of
    - Features/clusters on the map
    - Statistical information in the respective graph
- Different freely available base-map layers
- Freely available image resources in the form of philosopher portraits
- Information text on searched attributes (e.g., schools, eras or notable ideas)

The following set of gamification mechanics will be used to support the user goals of exploration and leisure:

- *Achievements:* as the only structural element the application uses from a "pointsified" approach to gamification, an achievement system is implemented for a dual purpose: a few achievements and their obtainment conditions are visible to the user in order to not only act as a motivating goal-setting device that informs users on which actions are possible within the application, but also to form a pivotal link between the core functionality of the application and the other game mechanics used, allowing for a smoother integration of the latter. A part of the conditions for obtaining achievements is unclear to the user in order to encourage self-exploration and to provide unexpected positive user feedback, while settong a challenge to obtain all achievements.
    - *Feature requirements*: The integration of an achievement system requires the monitoring of relevant user behavior with respect to the defined achievements as well as functionality to inform the user when an achievement is obtained and to view the obtained and still open achievements and their respective obtainment conditions. Additionally, a set of icons or small images is needed to depict the achievements.

- *Quests*: formulated as riddles in the style of the "Guess Who?" board game mechanic, the user has to identify a philosopher solely based on a uniquely defining description based on the combination of his or her attributes (e.g., born between 1750-1780, member of school X, …). The attempt to solve a quest provides the user with a task that makes the combination of different filter functionality as well as the use of the map and different graphs necessary, without prescribing the user what exactly to do and — so the design intention, nudges the user towards exploring the different functionality the application is providing.
    - *Feature requirements*: the mechanic requires functionality to display the respective quests and to allow the user to select their correct answer making use of the bookmark system. Quests have to be assembled from randomly chosen question fragments, varying in level of difficulty or complexity, their combinations have to be tested in order to provide a uniquely defining description as well as a non-tedious challenge.
- *Challenge or Combat*: after solving the quests the user has access to a challenge or "combat" (in the terminology of WERBACH/HUNTER 2012, p. 80). With the philosophers the user identified as solution during the quests, the user now embarks in a duel against as many other philosophers. The underlying base mechanic is conceived as a series of clashes in terms of comparisons of quantifiable attributes of the respective philosophers, whereas the design rationale behind this mechanic is to not only provide the user a reason to memorize attributes and combinations of attributes of the used philosophers but to also provide, due to the comparison, a contextualization of the features explored in the quests, thus indirectly supporting the goal of exploration.
    - *Feature requirements*: the mechanic requires the display and animation of the features taking part in the "combat", an appropriate feature selection mechanic for the user, as well as an own space in which the mechanic takes place. Furthermore, the definition and calculation of quantifiable attributes is necessary.
- *Story and narrative Elements*: the application uses narrative elements in the form of a brief story around two prominent philosophers and their entrapment within the application, mainly woven into the already existing tutorial. The story aims to provide a motivating and on-theme semanticization of the other game mechanics as well as to keep users interested in following the narrative, while providing a super-arching goal structure, as the philosophers can only be set free if a certain achievement threshold is reached.
    - *Feature requirements*: the narrative elements have to be created and built into the existing tutorial system. The additional integration in to the achievement system provides an event-based progression of the story.

5.1.4 Structure

The application primarily provides the user with two parallel access metaphors or "views" for exploring the information: an interactive map (I) and a series of interactive sequenced graphs (II) (see Fig. 5). As a primarily bottom-up approach to information architecture is chosen, the categories and subcategories are derived from the content. Basic unit of information is therefore the entity "philosopher". The user goal of exploration suggests using a matrix structure that allows the user to move from group of basic units of information to another along a number of dimensions expressed by attributes and combinations of attributes. Organizing principles for the information structures are the map, a series of graphs and, to some degree, the challenge or combat mechanic.

Both metaphors or organizing principles and their core functionality are explained in an optional preceding tutorial (2). If we consider NORMAN'S (2013, p. 40) stages of action model, the basic tutorial (2a) aims to provide not only knowledge about the relationship between tasks and operators but also to showcase tasks or even whole interaction exchanges. The gamified tutorial (2b) additionally aims to set an overarching goal for the use of the application with the help of narrative elements. From an interaction design perspective, the tutorial consists of a linear sequence of steps. The user has to simply acknowledge the information presented in a step or carry out a task (for example to click on a certain interface element) to get to the next step. During the tutorial the user's agency is drastically reduced to only the activities relevant to the active step.

After completing or skipping the tutorial the user has full access to the application, and may now choose to explore the map (I) or switch the view to display the graphs (II). The primary task the user may accomplish, if in (I), is to select a feature or a cluster of features directly on the map or use the filter functionality (3) to search for an attribute or a combination of attributes to select all features on the map that match the query. The filter is composed of a series of user input options that translate visually directly into the map view. The user may use additional functionality in this view to switch or toggle the map layers as well as to search for a geographical entity using the geocoder functionality.

Both, if filtered or directly selected, information regarding the selected philosophers is displayed in a separate info panel (IV). The user can browse through the selected philosophers, hyperlinked information allowing to directly filter for certain attributes, in term updating the map view. The info panel allows adding selected philosophers to the bookmarks or favorites to view them later. Additionally, the user can transfer the selection from the info panel into one of the graphs in (II).

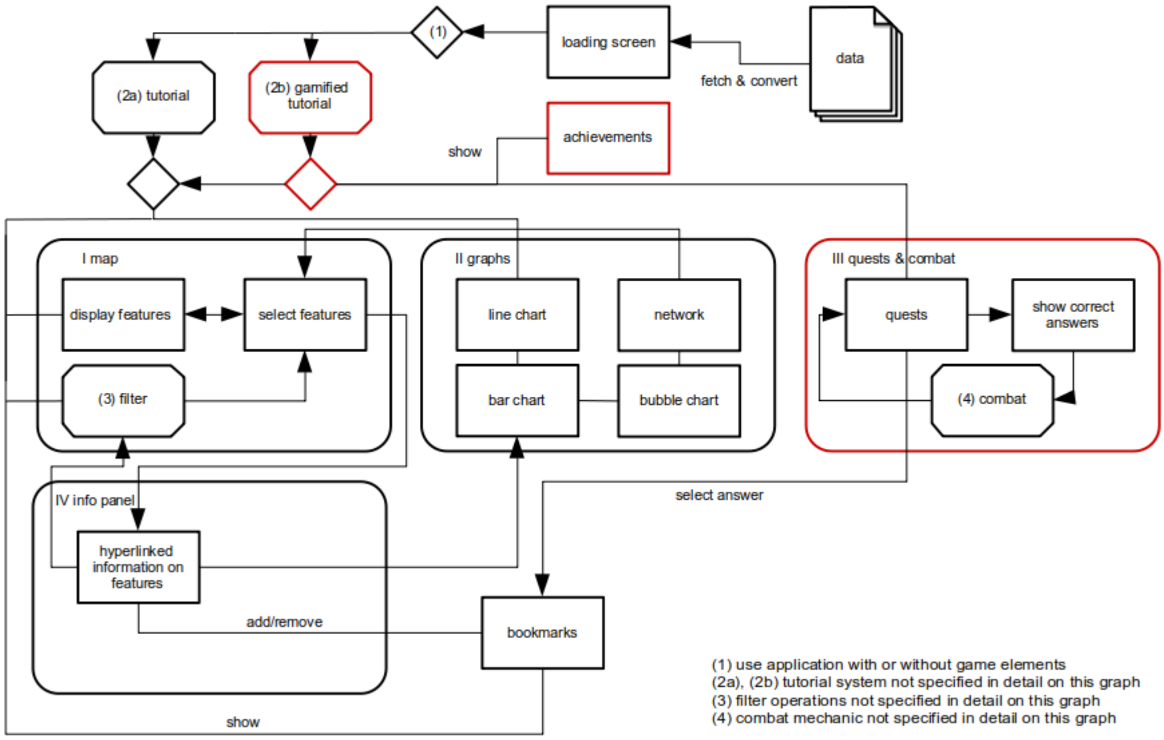

Fig. 5: Generalized interaction design (Source: own)

(Note: ludic interactions are framed red)

If the user switches to the graph view (II), without transferring a selection from the info panel (IV), a series of graphs is sequentially accessible, starting with an interactive line chart depicting the amount of living philosophers at a time axis. The diagram allows selecting an arbitrary time span and transferring the selection into a bar chart, where the displayed category may be changed interactively. A bar in the chart can be selected to be dissolved into its constituents: single philosophers depicted in a bubble chart. Lastly, a single philosopher can be chosen to be depicted as the center of a network chart, linking the respective philosopher with its influences or philosophers who were influenced by the selected philosopher. The chart allows further interactive and iterative exploration of the influences of the respective influences and so forth. At each graph functionality is provided to go back to the previous graphs to redefine the selection.

If the user chooses to use the ludic mode at the start of the application, a different tutorial (2b) is displayed, that not only acquaints the user with the core functionality but also tells a story while explaining the achievement system and showing the user how to access the quests. After skipping or completing the tutorial the user has, beside the core functionality, access to the achievements and quest panel. In the quest panel the user may look at and solve the quests by marking a philosopher saved at the bookmarks as correct solution. The quests, although not mechanically interfering with the core functionality of the application, do rely on the information the user gathers with the help of it in order to be solved. If a solution is proposed for each quest the user may continue with the challenge or combat.

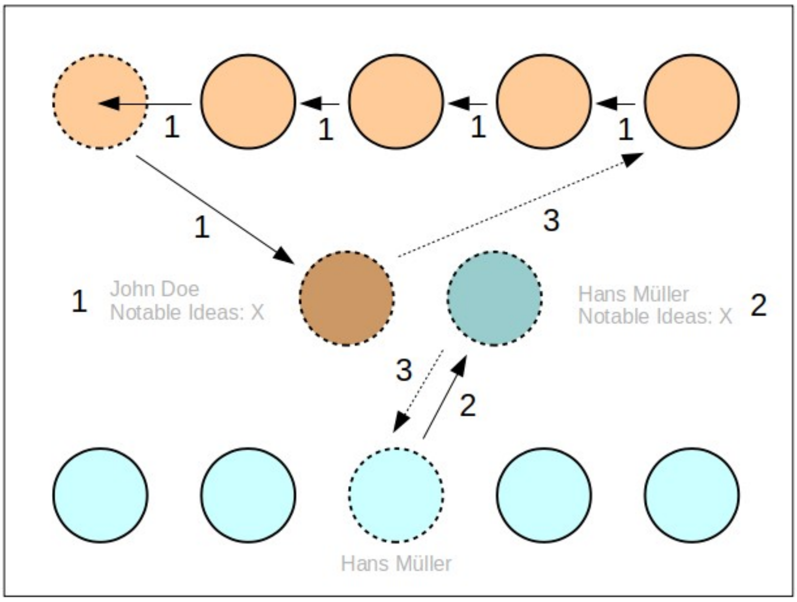

Fig. 6: Single interaction exchange in the challenge mode (Source: own)

The combat or challenge mechanic utilizes the well-known and intuitive conceptual model of trick-taking games. As shown in Fig. 6, the interaction takes place in a field consisting of ten circles — representing ten different philosophers —, five on the side of the user (turquoise) and five on the side of the computer (orange). The computer proposes a category, for example the number of notable ideas, and chooses the first philosopher on its side. The circle moves to the middle of the field and its value is displayed (step 1). Now the user has to select one of his or her philosophers while not having access to the attributes of the philosopher or other query functionality. The selected circle moves in the middle of the area as well and its value is displayed (step 2). Now the winner of the trick is evaluated, returning to its respective side (step 3), whereas the loosing circle is removed from the field. Starting again at step 1 a new interaction exchange is initiated and the next circle in line on the side of the computer moves to the middle. This process continues until no circles are left on one of sides. If the player has pieces left on his or her side, he or she may continue in an “endless mode”, where the challenge continues until the user has no philosophers, or go back to the main application. If the user has no philosophers on his or her side he or she may start from the beginning or go back to use the other functionality.

5.1.5 Skeleton

The basic user interface consists of four static elements: a title bar, a navigation bar, a main panel and an info panel (see Fig. 7). To underline the importance of the three organizing principles of information used in the application, the content of the interface’s *main panel* represents one of these at all time. The arrangement of interface elements in the map view follows the reduced looks and symbology of contemporary web maps, reducing the cognitive load by using design conventions. Apart from small pop-ups that inform the user about the philosophers name on hovering over a feature or cluster of features, all attribute information of selected features is displayed in the info panel to not counteract the reduced look and to support additional navigation systems serving free-form exploration. The view depicting a series of graphs in the main panel similarly aims to provide a reduced look and feel although the conventions governing interactive graphs may prove not as prevalent as those of web maps – a fact that a more intensive explanation during the tutorial tries to counterbalance. The quest view depicts five rearrangeable panels consisting out of the quest text and a blank rounded picture that allows the user by clicking on it to select a solution for the quest from the bookmarks. Additionally, buttons can be found in the top left area to show all correct solutions as well as to proceed in the challenge or quest mode, that is also displayed within the main panel.

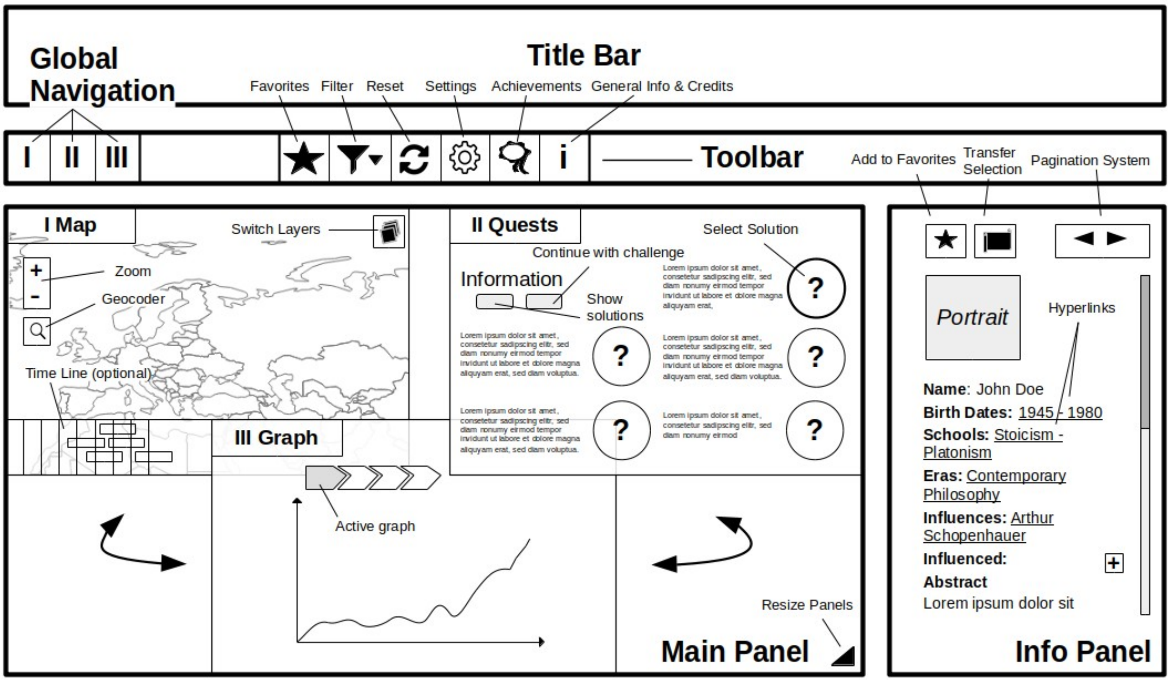

Fig. 7: User interface wireframe (Source: own)

(Note: The main Panel is completely filled with either the Map View (I), the Quests (II) or the Data View / Graphs (III))

The *navigation bar* provides the user with global access to the contents of the main panel, through which in term each basic unit of information is available. A toolbar provides easy and global access to core functionality such as the filter functions, the bookmark system and the achievement system (each displayed in a collapsible panel (see Fig. 8)). Additionally, courtesy navigation to rarely used functionality and information, like application settings and general application information, is provided.

The *info panel* is primarily used to display the user selection of philosophers and their attributes with the help of a pagination system allowing local navigation through the selection, while at the same time providing supplementary navigation in the form of shortcuts to filter functionality via hyperlinks and functionality to transfer the active selection in another non-active mode of the main panel (e.g., from the map to a graph).

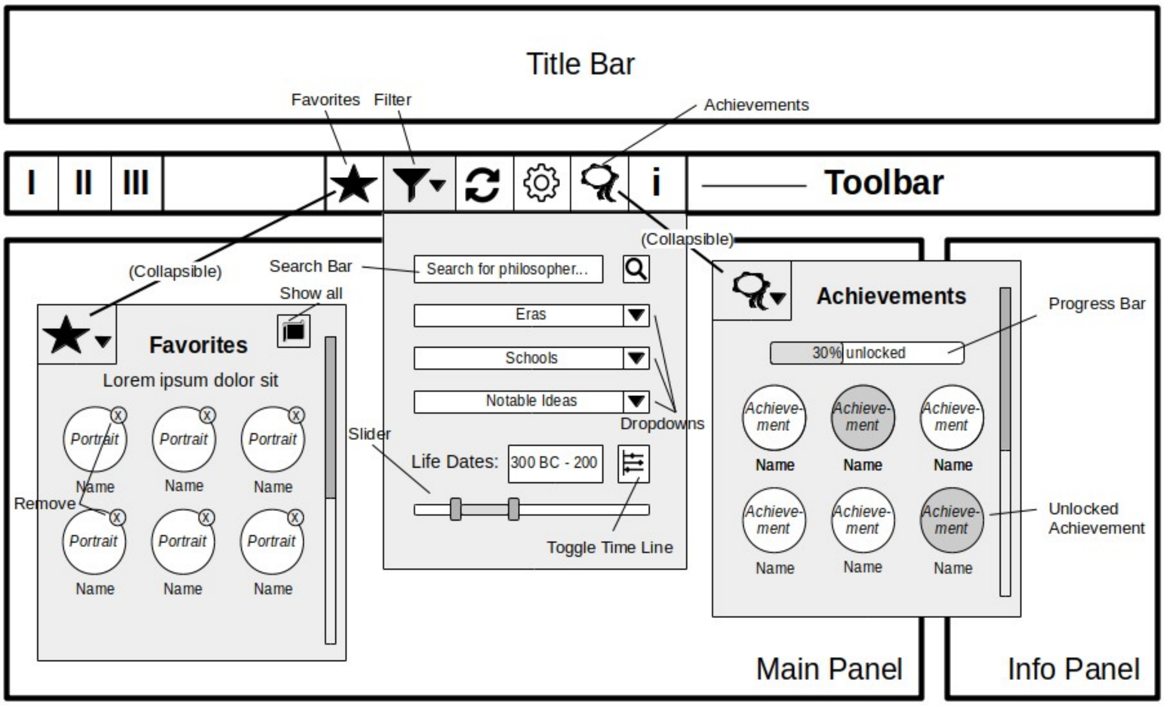

Fig. 8: Wireframe of collapsible panels in the toolbar (Source: own)

(Note: No more than one panel can be open at the same time. The "Favorites" and "Achievements"-Panels behave identically to the "Filter"-Panel)

5.1.6 Surface

The general design strategy of the application is to create the visual experience of an old paper atlas, while at the same time using design conventions and conceptual models of modern web applications. Due to its prototypical character, the style guide is reduced to a working minimum focusing only on color, the design of icons and interface elements and styling of the panel-based layout.

Supporting the design strategy, a color palette used throughout the application consists of color pairings reminiscent of old paper or parchment, bold or flashy colors are avoided. Colors of the palette are modulated via the transparency value to create nuances in boldness without introducing new hues. Icons and interface elements are selected according to their self-explanatory character and iconicity (see Fig. 7 and Fig. 8). Additionally, tooltips are displayed on hovering over interactive elements to provide textual information about the element's functionality to the user.

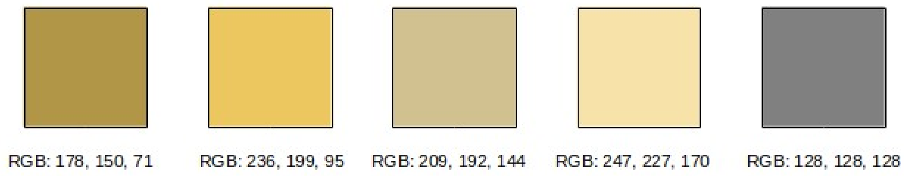

Fig. 9: Basic color palette (Source: own)

Bold colors of the palette are used to highlight interactive or important elements, light colors are used mainly for background areas.

5.2 Implementation

5.2.1 Prerequisites

As defined in the project objectives in the strategy plane of the design document (see Ch. 5.1.2) the application aims to use only open-source technology and avoids the use of additional data sources and libraries for gamification mechanics due to restrictions in developing time and know-how.

5.2.2 Data Acquisition

Main data source for the application is a dynamically extracted data set from DBpedia, a knowledge graph or special type of database that stores the knowledge accumulated on Wikipedia in a machine-readable form. DBpedia distributes data under the same licensing terms as Wikipedia, the Creative Commons Attribution-ShareAlike 3.0 license (DBPEDIA 2019). The relevant data of this immense database covering 4.58 million things in its ontology, is extracted from the SPARQL endpoint of Dbpedia's OpenLink Virtuoso server.

SPARQL is an SQL-like semantic query language for databases, originally designed to query data stored in the RDF data model (Resource Description Format) (DUCHARME 2011, p. 1). The RDF data model expresses facts as three-part statements, also known as triples, consisting of a subject (resource identifier of the thing being described), predicate (property name) and object (property value) part (p.2). A simple query, selecting all (*) cases or objects, where a subject (?p) has the predicate "philosopher" and the subject has one or more birth places, is looking as follows:

```
SELECT *
WHERE {
?p a  <http://dbpedia.org/ontology/Philosopher> .
?p <http://dbpedia.org/ontology/birthPlace> ?birthPlace
}
```

Note that as a philosopher may have more than one property value in the predicate birth place (e.g., a town, a region and a country) the output set of the query may contain more than one row with the same philosopher, one for each property value, making the use of subqueries, aggregates and functional forms in the SPARQL query — in order to group and filter values — necessary. Georeference is established indirectly through the coordinates of the respective birth places.


```
{ "head": { "link": [], "vars": ["phil", "bYr", "dYr", "schools", "eras", "nIdeas", "bPl", "type",
"lat", "long", "link", "thumbnail", "abstract"] },
  "results": { "distinct": false, "ordered": true, "bindings": [
    { "phil": { "type": "literal", "value": "A. D. Gordon" }    , "bYr": { "type": "literal", "value":
"1856" } , "dYr": { "type": "literal", "value": "1922" } , "schools": { "type": "literal", "value":
"Existential philosophy#Labor Zionism" } , "eras": { "type": "literal", "value": "20th-century
philosophy" } , "nIdeas": { "type": "literal", "value": "" }  , "bPl": { "type": "literal", "value":
"Zhytomyr" } , "type": { "type": "literal", "value": "City" }    , "lat": { "type": "literal", "value":
"50.25" }    , "long": { "type": "literal", "value": "28.666666666666668" }  , "link": { "type":
"literal", "value": "https://en.wikipedia.org/wiki/A._D._Gordon" }  , "thumbnail": { "type": "uri",
"value": "http://commons.wikimedia.org/wiki/Special:FilePath/Gordon_A.D.jpg?width=300" }    ,
"abstract": { "type": "literal", "xml:lang": "en", "value": "Aaron David Gordon (Hebrew:
\u05D0\u05D4\u05E8\u05DF \u05D3\u05D5\u05D3 \u05D2\u05D5\u05E8\u05D3\u05D5\u05DF\u200E\u200E; 9 June
1856 \u2013 22 February 1922), more commonly known as A. D. Gordon, was a Zionist ideologue and the
spiritual force behind practical Zionism and Labor Zionism. He founded Hapoel Hatzair, a movement that
set the tone for the Zionist movement for many years to come. Influenced by Leo Tolstoy and others, it
is said that in effect he made a religion of labor. However, he himself wrote in 1920, \"Surely in our
day it is possible to live without religion.\"" }},
```


Fig. 10: JSON-Data extracted from DBpedia (excerpt) (Source: own)

The application uses the following freely[14] accessible base map layers: Stamen Terrain, Stamen Monochrom and OpenStreetMap. Additionally, Stamen Labels can be activated to support base maps without text. Stamen Terrain is set as the default base-map due to its fitting color scheme.

A set of icons used in the achievement system is manually created from public domain pictures.

5.2.3 Application Architecture

The application runs client side and is written in JavaScript. OpenLayers, an open source[15] JavaScript mapping library, is used for the mapping functionality of the application (see Fig. 11). Additionally, three extensions or 3rd party libraries to OpenLayers are used to provide geocoding functionality (ol-geocoder), a layer switcher (ol-layerswitcher) and an integrated time line (ol-ext). Up-to-date JSON-Data is fetched from DBpedia with a

14 Map Tiles of the Stamen Maps are © Stamen Design, under a Creative Commons Attribution (CC BY 3.0) license, Map Data by OpenStreetMap under OdbL.

15 Released under the 2-clause BSD License.

SPARQL query via AJAX (Asynchronous JavaScript and XML) and converted to map features. If the AJAX call should fail, the application falls back to data saved locally on the webserver. Furthermore, the original data is parsed to populate the select menus with values. As the data is crowd-sourced, attributes are often labeled inconsistently, both in terms of spelling and degree of detail. A fuzzy-search library, Fuse.js, is at the core of the filter functionality to dynamically homogenize and combine attribute values in the categories “philosophical schools” and “philosophical eras” based on empirically determined thresholds, without permanently reclassifying the feature data.

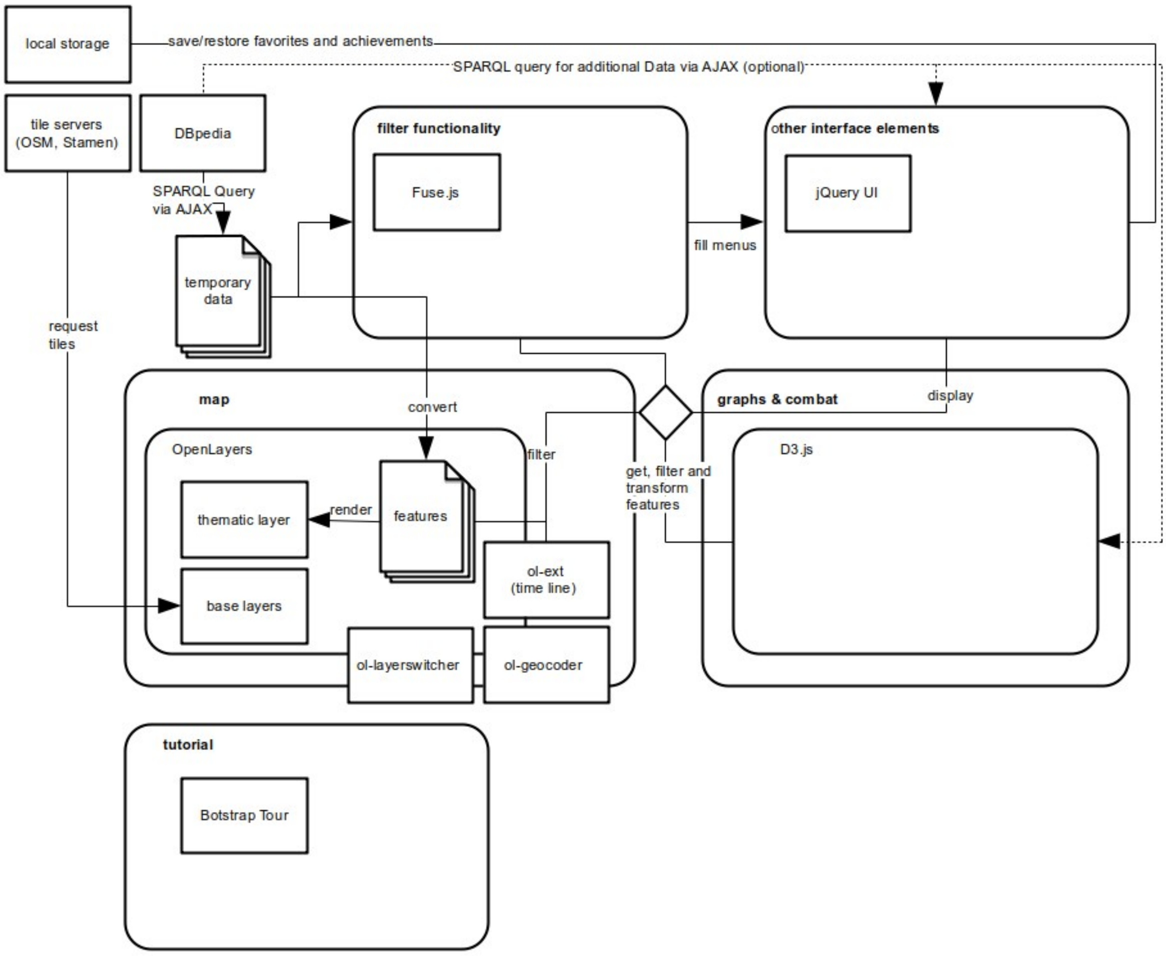

Fig. 11: Application architecture (simplified) (Source: own)

Beside pure HTML, CSS and JavaScript, jQuery UI, an extension to the jQuery JavaScript library for creating user interface interactions and widgets is used to build additional user interface elements and interactions apart from user interface elements and interactions in the map, graph and challenge view.

D3.js is utilized in the application to create a series of interactive charts, the transitions between them as well as the gamification mechanics in the combat or challenge mode. D3, or Data Driven Documents, is an open-source[16] JavaScript library for producing dynamic

16 Released under the BSD license.

and interactive visualizations of data, making use of SVG, HTML and CSS. The application converts the data stored in the map features to draw the charts with D3. This procedure allows not only for easy switching between map and graph view and common use of the same filter functionality, but also for an easy transfer of features from one view to another.

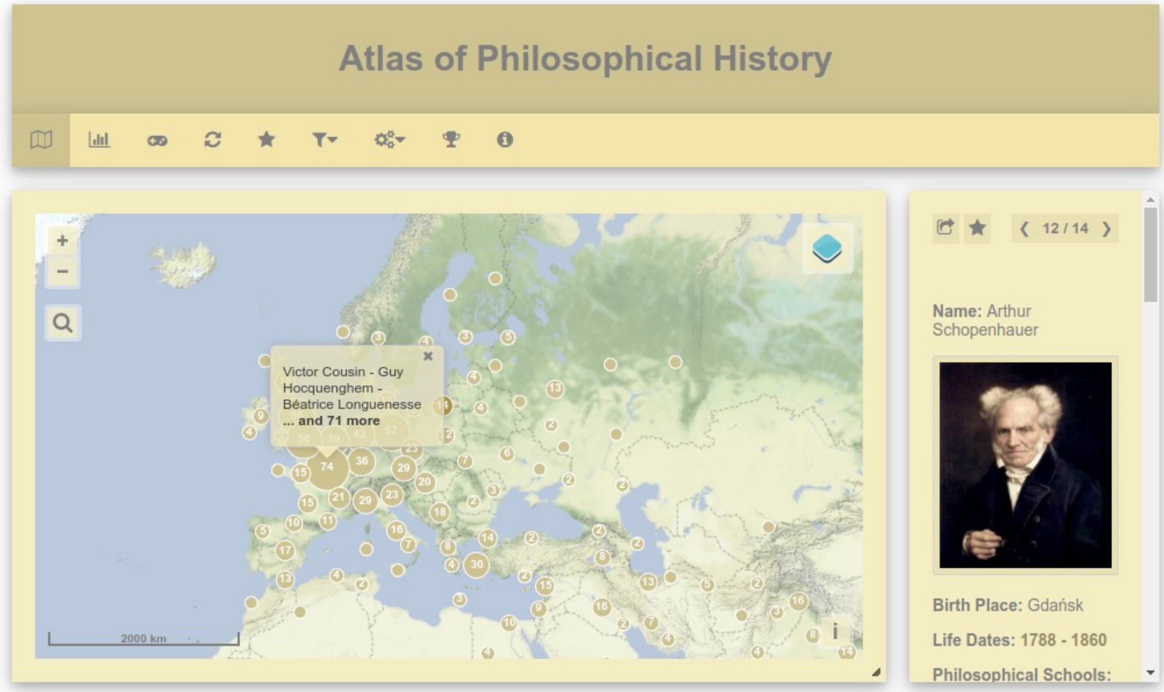

Fig. 12: Application prototype, map view (Source: own)

(Note: Further images, depicting different modes, can be found in the appendix.)

5.2.4 Issues

Due to the fact that the application runs client side and JavaScript does not allow true multi-threading[17], there exist some performance issues if complex iterative functions are called for the fuzzy classification process and quest building, causing a short freeze in some browsers.

A lack of internal data quality[18] of the data set extracted from DBpedia exists regarding completeness and logical consistency. Many attributes, including birthplaces, are missing, leading to problems with automatic georeferencing. Semantic heterogeneity regarding the ontology in DBpedia as well as the attributes of features can be found, which in term necessitated the construction of a complex SPARQL query — catching as many corner

17 A possible solution would be to use the Web Workers API (see HIWARALE 2018)

18 Internal data quality can be described as the level of correspondence between “perfect” data, that is data without error, and the actual data (DEVILLERS AND JEANSOULIN 2006: 36).

cases in the ontology as possible. Additionally, a fuzzy classification system had to be utilized to automatically group categories to semantical units, allowing for a more meaningful quantitative comparisons between attributes.

5.3 Outlook

The developed application show-cased, from a practical perspective, how the developed framework could be applied to inform and guide the design of a gamified web mapping application, pushing the use of ludic affordances beyond the simple and uninformed used of BLAP-gamification. A clear conceptual division in the application between a productive and a ludic mode allows potentially for further empirical testing to isolate the effect of ludic affordances on user engagement and experience (see SEABORN/FELS 2015, p. 29).

As the application could not be developed beyond prototype status and other restrictions regarding time, personnel and know-how existed, the following areas are in need for future improvement:

- At the surface level, the *design of panels* has to reflect an old paper look to a greater degree. This could be achieved by using old paper or parchment images as background or image borders for all panels, as well as with the help of a different font set. Additionally, *animations* could to be used to a greater extent to provide a better user experience and support the intended design goals.
- With respect to functionality, additional user research and testing is necessary in order to not only determine actual user needs with respect to the application, but to also to enhance or extend existing functionality. Potential for improvement exists regarding the *filter functionality*, as the combination of filter operations and the use of other filter operators is still not, or only at a base-level, integrated in the application. Selection and *seamless transfer* between the map and the data view is still subject for improvement, as currently only single features can be transferred from the data view back to the map view. The *network graph* displaying influences is still implemented on a rudimentary level. Possible avenues of enhancement would be to display and hide all links globally as well as to construct a complete graph — not only depicting one philosopher at the center — out of the influence data.
- From a perspective dealing with information, the main data set should be combined with thematic data from *other open data sources* or provide links to other copyrighted material (e.g., the Stanford Encyclopedia of Philosophy). Additionally, different *map layers*, depicting the added thematic data, should be envisaged to grant the application's title more credit.
- Regarding the ludic affordances of the product, more *playtesting* is necessary to ensure that the user experience goals are met and no negative emotions like frustration or boredom arise. From a gamification mechanics point of view, a few

adjustments in the challenge mode, like to restrict the selection of the same philosopher to once per two rounds as well as the possibility to change one of the philosophers with another one, unlocked already at a different round, are necessary to provide a richer and less repetitive gameful experience.

6 Summary

This thesis attempted to explore the potential and problems of gamification as a design strategy for applications in the area of cartography and GIScience. Both, from a theoretical and a practical perspective, it was examined how gamification may be utilized to potentially improve the design of geospatial applications. Key focus areas in this regard were the identification and uncovering of conceptual overlaps between gamification and existing research areas in cartography and GIScience as well as the development of a framework for the design of gameful geospatial applications out of existing frameworks and theoretical set pieces. The framework was further applied to inform and guide the design of a gamified web-mapping application, the Atlas of Philosophical History.

A first literature review on the core concepts of the thesis —*game, play, cartography* and *GIScience* — showed that no exhaustive definition, listing necessary and sufficient conditions, of the concepts of game and play can be given. A preliminary and heuristic classification scheme was developed to categorize the (possible) body of work in the overlaps of these concepts and to classify this thesis as part of the last of these research thrusts: *maps in games, maps as games* and *games in maps*.

Gamification, as part of a research field concerned with the use of game elements in non-game contexts, was further examined regarding its definitions, related concepts, theoretical underpinnings, game design elements, empirical findings, frameworks and implementation as well as problems, restriction and critique. It was found that neither a commonly accepted definition of gamification exists, nor seems to be there a clear and consistent grounding in theory of its disparate frameworks. Although many frameworks refer to established psychological theories like self-determination-theory (SDT) and the flow theory to provide a theoretical justification for the effectiveness of gamification in general, there is still gap between theory and action in gamification research (see Ch. 3.8). Regarding the empirical evidence of gamification, it was found that, although, there exists evidence that gamification improves user motivation and engagement, there is an absence of measures on the size of the effect of gamification in general as well as on the long-term effect of gamification due to the lack of longitudinal and comparative studies. Not only criticized due to its possible lack of empirical evidence, gamification has been subject to critique from game designers due to its lack of understanding of game design and limited or even exploitative use of game design elements. However, it was shown that serious objections to the outlined points of critique may be formulated (see Ch. 3.8.4): From a game design perspective, mainly the use of a reward-based or pointsified approach to gamification was criticized. This reductive view of early gamification was perpetuated in early applications, as designers were, using or theoretically ground only a “reduced sample” of game design elements, which consequently led to bias problems regarding empirical evaluation. From a methodological point of view, the attempt to derive universal quantifications on the effectiveness of certain game (interface) elements, thus taking only the mere surface structure of game layers and not the mechanics, patterns or rules that govern these elements, into account, could be raised to question.

A literature review on gamification and its related concepts in the field of cartography and GIScience has been conducted in order to provide an overview to which degree, in which application areas and with which theoretical impetus these concepts were utilized in the respective fields (see Ch. 4.1). The review showed that the discourse regarding gamification developed from early explorative work, calling for the conceptual embedding of games or game elements, over first prototyping — for the most part uninformed of game design and gamification theory —, and more detailed analyses with respect to the potential of using video games within the domain, to a level of advanced application building, although mostly lacking thorough theoretical underpinning. It was found, that a striking duplexity of limitations within these discourses could be located: the analyzed body of work suffers from *methodological limitations*, as theoretical links to the gamification concept remained superficial, the concept was reduced to pointsification and only mechanistic gamification frameworks — if at all — have been used in the design of applications, therefore confirming the results of the general literature review on gamification regarding a wide open gap between theory and practice. Additionally, the discourse suffered from *practical limitations* as application design was mainly concerned with the same interrelated topics of VGI, crowdsourcing and geographic data collection, other application scenarios — such as educational or training applications — played only a minor role and were found mostly in the context of serious games.

To tackle the outlined practical limitations and to present arguments for the potential of gamification, closer theoretical linkage and conceptual overlaps to the gamification concept have been provided for a number of concepts and research areas in cartography and GIScience. It could be shown (see Table 7), that possible points of contact exist regarding the use of interactivity, multimedia and new ways of user engagement to *Cybercartography and Multimedia Cartography*. *Cartographic or geospatial interface and interactivity design* show a lot of common threads to gamification with respect to user-centered interface and (game) interaction design. *Narrative and Emotional Cartographies* provide points of contact and application potential in the common use of narrative structures, emotional and persuasive design or design for pleasurable experiences. *Critical Cartographies* and *post-representational Cartographies* can conceptually be tied to gamification regarding their focus on new and gameful mapping practices, as well as due to their new ontogenetic and processual understanding of maps.

A user-centered framework building on existing (gamification) frameworks, game design literature, theoretical insights in conteptual overlaps as well as (cartographic) interaction design was developed in order to not only guide the design of an application and therefore contribute also in an applied way to the overcoming of the practical limitations regarding the use of gamification, but also to aid in the overcoming of the methodological limitations by providing a specialised framework (see Ch. 4.4). The developed framework follows GARRETT's (2011) fives progressive stages or planes, initially developed for the design and implementation of web pages or applications. The framework extends the original basic duality of modern interactive (mapping) applications of the product as platform of functionality and as medium of information by adding a third component, the product as affordance for gameful experiences, allowing the conceptualization of the relationships between these three parts at each stage as well as guiding the design of ludic affordances across all levels of abstraction (see Table 8).

The developed framework was utilized for the design of the Atlas of Philosophical History (see Ch. 5), the practical part of this thesis. Aimed at overcoming the diagnosed limitations in the field of discourse by providing a use case in the more ubiquitous context of explorative web-mapping applications as well as using a design strategy that ties gameful affordances closely to application goals and tasks while avoiding a pointisified approach to gamification.

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8 Appendix

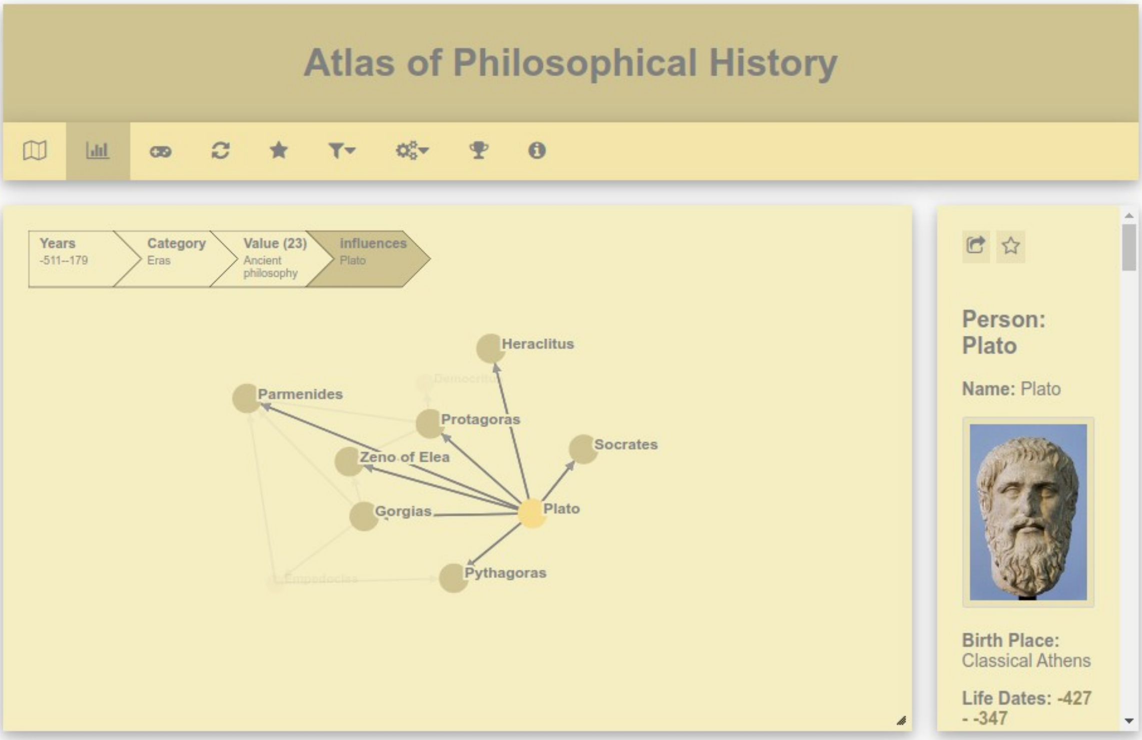

Fig. 13: Application prototype, data view, network graph (Source: own)

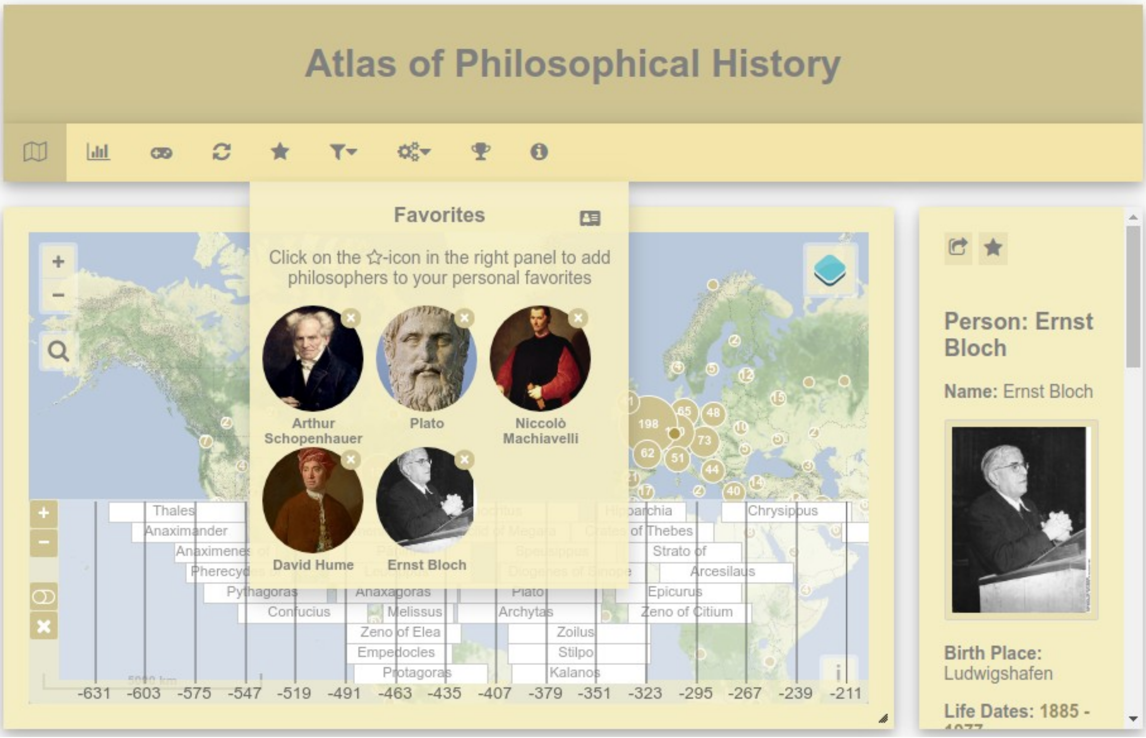

Fig. 14: Application prototype, map view, favorites tab and time line (Source: own)

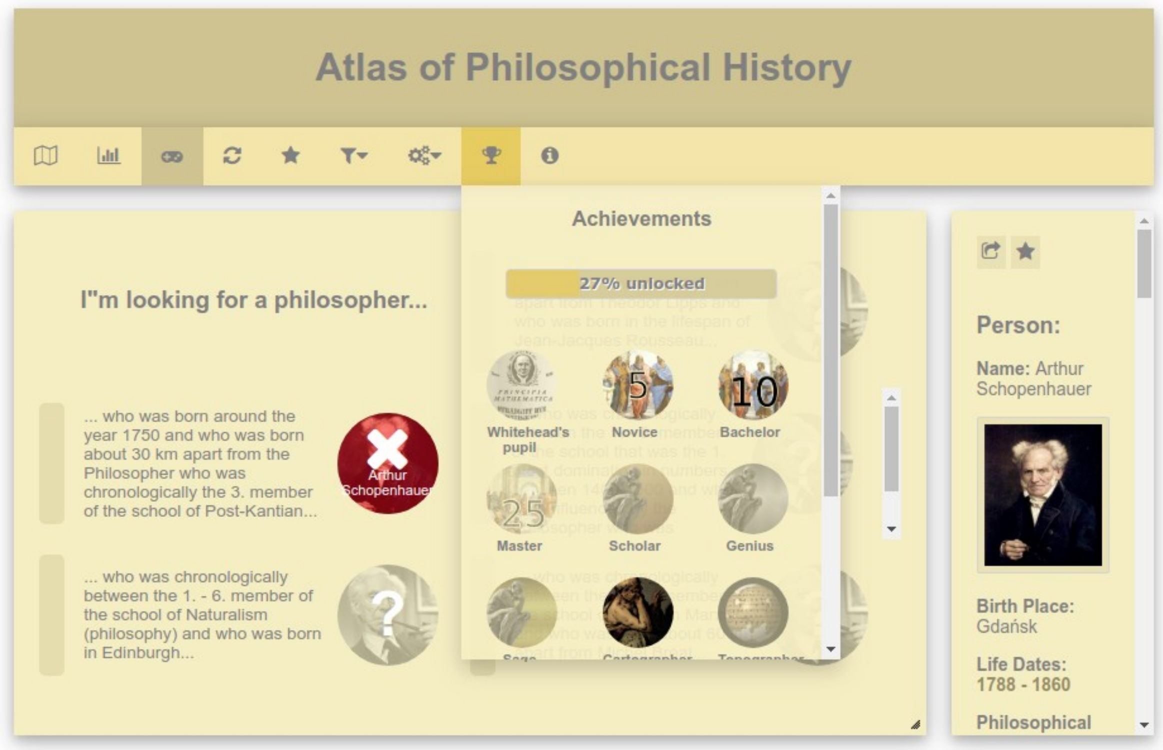

Fig. 15: Application prototype, quest view, achievement tab (Source: own)

Fig. 16: Application prototype, challenge view (Source: own)