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Developing Playability Heuristics Based on Nouns and Adjectives from Online Game Reviews

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ABSTRACT

The objective of this study is to develop playability heuristics based on a lexical analysis of nouns and adjectives frequently used in online game reviews. Built on a previous lexical analysis of adjectives in online game reviews, it is argued that nouns together with adjectives will likely provide more contextual information than adjectives alone, and therefore the patterns among these words can be used to develop playability heuristics. A revised lexical approach is adopted to analyze nouns and adjectives from 821,122 online reviews. Ninety seven factors emerge from this analysis. Based on the nouns and adjectives highly loaded on these factors, a new process is introduced and 90 playability heuristics are derived. This study significantly expands the current pool of playability heuristics that facilitate the computer game design process. The lexical method adopted in this study demonstrates its effectiveness in developing interface design guidelines based on a large number of online reviews on a system or product. It can be extended to other fields that are human-behavior centered.

1. Introduction

According to the Entertainment Software Association (2015), at least 150 million people play video games in the United States of which 42% of them play regularly or 3 h/week. Sixty-three percent of parents see video games as a positive component of their children's life and 85 of them maintain that game play brings fun to their families. Given the strong growth of the multibillion dollar computer game industry, the rising popularity and proliferation of computer games deserve systematic examination on game play experience (PX) and its impact on game design.

However, the notion of PX with computer games should be differentiated from the one of user experience (UX). Malone (1982) suggested that it is important to distinguish toys-systems from tools-systems. Games belong to the former category and typically do not require an external goal. Moreover, the PX is more extensive than UX with productivity software (Sánchez, Vela, Simarro, & Padilla-Zea, 2012) because the former is affected by many design factors. Therefore, playability is a more appropriate measure for computer games. A few studies have extended beyond the scope of usability and created instruments to measure some aspects of playability such as game enjoyment (e.g., Fang, Chan, Brzezinski, & Nair, 2010; Fang, Zhang, & Chan, 2013; Qin, Rau, & Salvendy, 2009). This line of work indicates, to a certain degree, that playability is not equivalent to usability in the eyes of researchers.

Barr, Noble, and Biddle (2007) indicated that computer games are not made to support user-defined tasks and thereby should not belong to the line of productivity software. From this standpoint, one can make two reasonable arguments: (1)

usability heuristics are less applicable to computer games and (2) a different set of playability heuristics must be developed for computer games.

As of now, only a few researchers have tried to develop playability heuristics (Desurvire, Caplan, & Toth, 2004; Federoff, 2002; Malone, 1982; Pinelle, Wong, & Stach, 2008). Most of these heuristics are subject to three major flaws: (1) these heuristics are usually derived from a small data set. They may not represent or reflect the most critical problems in most players' PX. (2) These heuristics are usually based on qualitative data and they are not empirically validated. And (3) these heuristics often focus on a very limited number of games and may not be applicable in a more general context.

With more and more game players actively participating in online forums, there is a growing volume of game reviews posted on major game websites. These online reviews contain rich information about game PX. They have been voluntarily contributed by players in non-experimental settings. Researchers have begun to acknowledge the values of these contents. For instance, Pinelle et al. (2008) developed a set of playability heuristics by analyzing expert reviews from Gamespot.com. In the general area of human-computer interaction (HCI), online content has also been utilized in empirical studies. Hedegaard and Simonsen (2013) identified usability dimensions by extracting usability and UX information from product reviews on Amazon.com.

This study attempts to fill in the research gap in game playability and to develop comprehensive playability heuristics through a lexical analysis of nouns and adjectives used in online game reviews. Since game reviews cover a large

collection of games being played on various platforms, the heuristics should be applicable to both console video games and computer games. The article is organized as follows: (1) Playability and Playability Heuristics, (2) the Lexical Approach and Prior Lexical Analysis, (3) Lexical Analysis of Nouns and Adjectives, and (4) Results and Discussions.

2. Playability and Playability Heuristics

Currently, there is no consensus on the definition of playability. Usability-First (2009) defines playability as “the degree to which a game is fun to play and is usable, with an emphasis on the interaction style and plot-quality of the game; the quality of gameplay.” When it comes to individual researchers, Fabricatore, Nussbaum, and Rosas (2002) pointed out that “playability is the instantiation of the general concept of usability determined by understanding and controlling gameplay.” Sánchez, Simarro, Zea, and Vela (2009) viewed playability as the UX in videogames and defined it as “a set of properties that describe the Player Experience using a specific game system whose main objective is to provide enjoyment and entertainment, by being credible and satisfying, when the player plays alone or in company.” Paavilainen, Korhonen, and Saarenpää (2012) considered playability as the combination of gameplay and user interface, which links to concepts of intuitiveness, unobtrusiveness, fun, and challenge. Since these definitions shift focus between game play and usability components, confusion between playability and usability remain unaddressed. Above all, there are few playability heuristics that game designers and developers can easily apply with consideration of a specific aspect of gameplay.

To enumerate a few major heuristics, Malone (1982) discussed three motivational factors for designing enjoyable interfaces: (1) challenge, (2) fantasy, and (3) curiosity. He designed a series of experiments by controlling the elements relevant to the factors in educational games. The subsequent analysis yielded a design framework, which had a far-reaching significance for playability research and heuristics development.

Federoff (2002) established the first playability heuristics set for games that are made for entertainment purposes. Their heuristics set is distinctive in that it was developed in the context of the traditional usability heuristics and game design principles. Further, they conducted the study *in situ* a game company, which makes the heuristics more applicable to daily practice. However, there is no formal validation process in the end.

Desurvire et al. (2004) published a heuristics set that contains 43 items organized into three categories. Unlike Federoff's work (Federoff, 2002), a strong part of this study is its validation against traditional user testing. The outcome demonstrated the success of the heuristics in seeking playability issues.

As many computer games are portable, Korhonen and Koivisto (2006, 2007) proposed playability heuristics for games running on mobile devices. Korhonen, Paavilainen, and Saarenpää (2009) also mentioned that their evaluation model was independent of technology platforms thus the heuristics can be used for other types of games.

Perceiving the potential merit of user-generated contents online, Pinelle et al. (2008) built a list of heuristics by analyzing 108 PC game reviews from GameSpot.com. They identified and

classified issues reported in the reviews. They then translated these issues into principles and describe them at a higher level. The study, however, focused on user interface more than other gameplay elements. Further, the authors sampled PC-based multiplayer games, which was insufficient to cover all the classes of games.

As social networking games began to attract consumers on the Internet, Paavilainen (2010) introduced an initial set of social game heuristics based on two existing design frameworks (Järvinen, 2009; Ventrice, 2009). The heading-level heuristics contain 10 items such as spontaneity and narrativity.

Each set of the above heuristics has its own strengths and weakness. However, they all fail to incorporate viewpoints of the majority of consumers who have different tastes for computer games. This study strives to address this issue by examining a large amount of online game reviews. Since online game reviews include user-generated content concerning their PX, they will likely provide rich information and serve as a fertile ground for developing playability heuristics.

3. The Lexical Approach and Prior Lexical Analysis

The lexical approach was initially suggested by Galton (1884) in personality research on. Its concept stems from the lexical hypothesis, which states that when salient individual differences become socially relevant to human life, these distinctive attributes are encoded into nature languages. If many people recognize a difference, the difference is likely to be expressed by similar words. Personality traits therefore can be identified by exploring personality descriptive adjectives in natural languages. There are three basic steps to apply a lexical approach (Ashton, 2007, p. 1): (1) a researcher first searches through the dictionary in order to garner a list of personality-descriptive adjectives; (2) after attaining the adjectives, the researcher removes the ones that are rarely used; (3) the final list is then administered to a large sample of participants who are asked to provide self-ratings on these adjectives, indicating the extent to which each adjective describes their own personality.

Allport and Odbert (1936) located almost 18,000 personality related terms in the Webster's New Unabridged International Dictionary. A few decades later, Norman (1967) added 171 more traits terms by examining a newer edition of the same dictionary. Their intention was to identify all words capable of differentiating one person's behaviors from another. Since the original list would be immense to study, Allport and Odbert (1936) further divided them into four groups: personality traits, temporary states, social evaluations, and metaphorical or doubtful terms.

Cattell (1947) is known as the first researcher to conduct an oblique factor analysis of ratings on personality-descriptive adjectives in the English language. Cattell (1943, 1945a, 1945b) first built a multi-dimensional personality structure based on the personality trait category proposed by Allport and Odbert (Allport & Odbert, 1936). By semantic and empirical clustering and referencing personological literature, Cattell was able to narrow about 4500 trait terms down to 171 trait terms. He then asked participants to use adjectives from the refined list to rate people they knew in person. After analyzing the ratings, he discovered 35 groups of personality

spheres and 12 personality factors. However, other studies (e.g., Tupes & Christal, 1992) displayed a consistent set of five personality factors after re-examining his correlation matrixes. The five personality factors later became the well-received Big Five personality factors, which are namely: openness, conscientiousness, extraversion, agreeableness, and neuroticism (e.g., Goldberg, 1990).

Inspired by the lexical approach used by psychologists to study human personalities, we adopted this approach to analyze adjectives from online game reviews (Zhu, 2013, 2014). The lexical analysis of adjectives has unfolded six significant factors in game PX: playability, creativity, usability, competition, sensation, and strategy. While competition, sensation, and strategy serve as the stimuli factors arousing game enjoyment, playability, creativity, and usability can be used to measure to what extent a computer game is successful.

Although a lexical analysis of adjectives in online game reviews successfully reveals general traits of computer game play, it does not reflect the subjects and contexts of using these adjectives. Therefore, playability heuristics (i.e., design guidelines for computer games) are still out of reach. In this study, we propose to incorporate nouns in the lexical analysis as well because nouns may suggest what subjects the adjectives have been used to describe and therefore provide more context-oriented information. In addition, nouns and/or noun phrases are more likely to encode a wealth of game design concepts in the form of natural languages. Since adverbs normally modify adjectives, verbs, and other adverbs, they are not factored into this study.

We argue that a lexical analysis through the combination of nouns and adjectives will likely achieve two objectives: (1) discovery of general patterns among online game reviews and (2) context-specific information concerning different aspects of player experience. These two findings will likely lead to a prolific set of playability heuristics that can be helpful to game developers in the context of their design goals as well as creative visions.

4. Lexical Analysis of Nouns and Adjectives

Two phases were involved in developing playability heuristics based on nouns and adjectives.

4.1. Phase I: The Lexical Analysis

There are mainly four stages in the revised lexical approach in our early work (Zhu, 2013, 2014): (1) collecting online reviews, (2) building a dictionary of game descriptive adjectives, (3) extracting ratings of adjectives from game players, and (4) exploring patterns through factor analyses.

In our previous work (Zhu, 2013, 2014), we have downloaded 821,122 reviews from three major game websites (e.g., gamespot.com, gamestop.com, ign.com). The nature of these reviews varies from player's self-reflection on PX to objective introduction of game design/technical facts. Since we were interested in nouns (including game jargons) in this study, we took some additional steps based on our workflow that was introduced in Stages 2 and 3 (Zhu, 2013, 2014):

- Step 1: Gleaning nouns/noun phrases and game jargon terms from reviews;
- Step 2: Extracting player ratings of nouns;
- Step 3: Refining the list and conducting factor analysis.

Step 1: Gleaning nouns and game jargons

Four tasks were involved in this stage: (1) parsing individual lexicons from original texts and checking the part of speech (PoS); (2) detecting nouns and phrases as non-adjectives in the sentences; (3) dropping stop-words; (4) registering overall frequency and the number of game reviews containing a word. Natural Language Processing (NLP) programs were developed using Perl to carry out these tasks.

Since user-generated reviews are often poorly written with informal languages, we chose a basic parsing strategy. The programs examined a word's sense semantically instead of analyzing the entire sentence syntactically. WordNet (Fellbaum, 1998; George, 1995) served as the main reference because it offers a wealthy lexical library that documents words of four PoS. It also provides a comprehensive set of senses for each word.

Three computers ran in parallel to process eight tables of textual data. Once a possible game descriptive term was found, it was inserted into the designated table with two updated frequencies—the absolute number of the term's occurrences in the entire pool of content, and the number of distinct reviews hosting the term. The ratio of the former to the latter generated a value that indicates the average use of the term per document.

Based on 821,122 reviews, 21,535 distinctive nouns/noun phrases were found. In addition, there were approximately 4327 jargon terms with an absolute frequency ranging from 10 to 8033. The least popular nouns/noun phrases only appeared once; on the contrary, the most frequent nouns/noun phrases were covered in 100,532 game reviews.

Step 2: Extracting player ratings of nouns

At this step, the online reviews were transformed to a matrix by a computer program as follows: (1) each noun or jargon was treated as an individual item. The terms were relabeled as the field names of the matrix table; (2) all online reviews were retrieved one at a time. Each review about one game was processed as an individual document. If a term appeared in this review, the value for this noun or jargon (i.e., field) was set to 1. Otherwise, a zero value was registered.

The computation at this step was iterative, as low variance terms often forced the program to exit with errors. Therefore, we needed to discard terms that contribute insignificant variances (e.g., 1.4292779E - 6). Since players rarely used them in online reviews, it is unlikely that they would lead to useful insights. After removing those terms, we re-computed the correlation matrix until all the remaining terms generated ratings.

As a result, 4342 items were retained in the final analysis from 821,122 reviews. These terms were then combined with the adjective list produced in our prior lexical analysis (Zhu, 2013) to form a new list. This mixed list was used in the subsequent factor analysis.

Step 3: Refining the list and conducting factor analysis

This step began with an exploratory factor analysis with varimax rotation. We used un-weighted least squares method

and estimated communalities by square multiple correlations. A number of 147 factors emerged from the first round of analysis. It was noticed that there was redundant information among the 147 factors.

To address this problem, we consolidated nouns with similar or opposite meanings as what we did to adjectives. To elaborate more, the underlying algorithm consists of three parts: (1) for each noun in each of the 147 factors, we looked for other terms in that factor based on three relations: *syns* (i.e., *synset* words), *sim* (i.e., *similar to*), and *ants* (i.e., *antonyms*). As a word may have more than one PoS type or sense, we only acquired its senses under “noun” notation. The correlations between any two words were pre-checked to ensure statistical significance; (2) if a query to WordNet returned words that were not from the list, the process would simply ignore them; (3) after moving an item to a destination group, the algorithm would immediately take the item off to avoid any further processing, even for other factors. The process resulted in 3044 groups of nouns. The items within each group are both semantically relevant and statistically correlated.

After combining the 788 adjective groups from prior work, 1298 popular game jargons, and 3044 noun groups, a new hybrid list of 5130 terms was formed. It served as the base for an updated rating matrix through a slightly different conversion process. In particular, for each review, the number of distinct adjective or noun terms from the same group appearing in the same review was used as the value of this group in this review. A second factor analysis was conducted.

The lexical analysis of nouns, adjectives, and jargon terms yielded 97 factors. Each factor was loaded with a group of tokens related to each other for an unobservable reason. The next task was to interpret why and how these words were related.

4.2. Phase II: Developing Playability Heuristics

In Phase II, each factor was analyzed in the following four steps in order to formulate playability heuristics: (1) sorting terms in a factor according to factor loadings, (2) identifying terms relevant to potential heuristics, (3) composing initial heuristics, (4) refining playability heuristics. We will use Factor #31 as an example to illustrate these steps.

Step 1: Sorting terms in a factor according to factor loadings

We wrote a script to rank the terms in a factor based on their loading values. The PoS tags were retained during sorting. It became immediately noticeable that highly loaded terms in a factor may suggest a prominent game play context. Taking Factor 31 for example, the first three factor descriptors —“Japanese,” “Anime,” and “Turn-based” clearly represent the inherent characteristics of Japanese-RPGs. It is reasonable for them to stand out among other terms, as players may have frequently used these three as generic descriptors. Other words such as “Anime-like” and “Japanese-style” with lower loadings also confirm this presumption. Those context-oriented terms introduced a primary context/background to investigate the factor. Table 1 lists the words loaded on Factor #31.

Table 1. Nouns and adjectives loaded on factor #31.

Factor	Original terms and factor loadings	Selected terms for developing playability heuristics
Factor #31	Japanese (a): 0.2297 Anime (np): 0.21537 Turn-based(j): 0.18741 Boy daughter girl son (np): 0.15629 English (a): 0.14535 Dragon (np): 0.10936 Atelier (np): 0.09365 Side-quests(j): 0.08356 Cel-shaded(j): 0.08298 Composer (np): 0.07932 Sonata (np): 0.07066 J-pop(j): 0.07043 Scholar student (np): 0.06973 Anime-inspired(j): 0.06962 Saga (np): 0.06705 Cel-shading(j): 0.06435 Sria (np): 0.06399 In-battle(j): 0.06308 Gust (np): 0.06222 Hearts (np): 0.01842 Oldie (np): 0.01819 Cleavage (np): 0.01709 Skit (np): 0.01645 Reincarnation (np): 0.01516 Censorship (np): 0.01486 Fandom (np): 0.01394 Highschool (np): 0.00937 Incest (np): 0.00413	Japanese (a) Anime (np) Turn-based (j) English (a) Side-quests (j) Cel-shaded (j) Anime-inspired(j) Cel-shading (j) In-battle (j) Level-grinding (j) Side-quest (j) Non-playable (j) Randomly generated(j) Fan-service (j) Cell-shading (j) Translator (np)

Step 2: Identifying terms relevant to potential heuristics

The list for each factor usually consisted of nouns and adjectives with continuous factor loadings. This step aims at short-listing truly useful words for drafting playability heuristics. The entire list was studied in relation to the context. To ensure the validity of any playability heuristic to be developed, original player reviews were examined.

Commonly used words that lack useful information were first excluded. The following five types of words were considered irrelevant: (1) terms reflecting a component in the game such as plot and character. In Factor 31, those items include “daughter,” “girl,” “son,” “dragon,” “gust,” “swordsman,” “grimoire,” “airship,” “scholar,” “student,” “highschool,” “harmony,” “omega-xis,” “kos-mos,” “sol,” “childhood,” “z-saber,” “hearts,” “reincarnation,” and “incest.” (2) Terms used in the title of a game or sequel. They can be a popular element in game storylines as well. With regard to Factor #31, these items are “boy,” “atelier,” “sonata,” “fencer,” “saga,” “grimoire,” “nocturne,” “vandal,” “bride,” and “radiance.” (3) Terms entailing meta-data related to a game or sequel. “Composer” as a generic noun term is often mentioned in reviews of Final Fantasy. Reviewers keep mentioning its composer because of their excellent work on the soundtrack. Another term “Square-Enix” is the developer of Final Fantasy. (4) Terms emphasizing the theme or style of a game or sequel. In Factor #31, those items are “spiky-haired,” “anime-like,” “over-world,” “Japanese-style,” “rpg-style,” “adult-oriented,” “j-pop,” “zelda-like,” and “anime-ish.” (5) Terms describing generic gameplay features. Those items loaded in Factor #31 are “mid-battle,” “action-rpgs,” “friendship,” and “auto-battle.”

As the result of this step, a shortened list of words was used to query the original player reviews. For Factor #31, 16 words were chosen for this purpose (see Table 1). The first three context descriptors on this list were “Japanese,” “anime,” and “turn-based”).

Step 3: Proposing initial heuristics

Original player reviews combined with nouns and adjectives loaded in a factor were examined and converted into playability heuristics with consideration of general user-interface design principles. Playability heuristics were stated as specific as possible in order to preserve relevant contextual information.

The process began with analyzing reviews containing highly-ranked terms. In Factor 31, the words “Japanese,” “Anime,” and “English” were used to query original reviews. This pattern expresses players’ support for keeping original voice-acting in certain themed games. Although language options are often available, most players prefer the original “Japanese” voice-acting, as it narrates stories better than “English.” Since storytelling is an effective tool in user engagement, this finding is a unique discovery about game play. One hundred forty six online reviews with similar suggestions supported this heuristic.

“Side-quests” and “side-quest” encode the request for a fair playfulness in non-primary tasks. The reviews tell us that there should be plenty of fun side-quests so players will stay entertained. In addition, these secondary tasks may help players better explore the game world. 2823 online reviews with similar suggestions supported this heuristic.

For Factor #31, 12 out of 71 terms resulted in 10 raw playability heuristics. Table 2 presents two sample rules.

Step 4: Consolidating playability heuristics

Two tasks were performed to consolidate the first draft of playability heuristics:

- Additional information was collected from original reviews to substantiate each drafted heuristic. The number and content of reviews related to each heuristic were analyzed. Sample reviews supporting a heuristic are presented along with it. Heuristics were rephrased to better reflect player comments. Heuristics without strong support in original reviews were removed.
- Similar heuristics were combined together and merged.

Table 2. Sample playability heuristics based on factor #31.

Terms	Draft Playability Heuristic	Sample Game Review
English Japanese Anime	For English versions of Japanese-style games, users may prefer the original Japanese voice-acting with English subtitles	“I still prefer using Japanese voice w/English subs since there are some things that the Japanese could say better.”
Side-quest Side-quests	Users expect fun side-quests in addition to the main tasks or missions	<p>“A valiant attempt to add some spice to the over-populated SRPG Genre but boring side-quests and poor art hold it back.”</p> <p>“Unfortunately, a cliché story, poor art direction, and boring side-quests take fun combat and make it insanely repetitive.”</p>

For Factor #31, 10 drafted rules from previous phase were consolidated into 7 heuristics. An initial set that consists of 116 playability heuristics was developed based on all 97 factors. They are grouped into the following three categories: playability, creativity, and usability.

Step 5: Refining Playability Heuristics

Fully aware of the limitations by using a single coder, two additional coders contributed to refining the initial list of playability heuristics. The coders, who had no connection, both had a research background in HCI and IS. The first coder had extensive experience with playing a large collection of computer games and the second had intermediate gaming experience. The procedures remain the same and they are discussed in the previous steps.

Only three of the seven heuristics proposed for Factor#31 were retained after this stage. Depending on the nature of candidate heuristics, some rules in the refined list were broadly defined purposefully for a wider scope of computer games. Some others contained very specific information that intended to facilitate design-oriented understanding.

For instance, among the three independent coders, two coders believed that “Side-quests” and/or “side-quest” was highly desired for game play, but suitable challenges had to be present when it came to non-trivial outcomes and rewards. Previously, it was only mentioned “side-quests and/or mini-games should be equally fun.” For the keyword of “level-grinding,” the heuristic became more elaborate because two coders believed that level-grinding should be sufficiently arduous and not too tedious. Adding too much weight on either end may cause a low level of playability. This new insight is not introduced by the former interpretation that mainly emphasized on the harm of repetitive tasks to the game. The refinement made by multiple coders clearly covered more facets of game play, thus helping render a more balanced view of game design.

Appendix A presents the entire set of playability heuristics. Appendix B displays the selected terms from which heuristics were drawn and their factor loadings after the second factor analysis. The overall inter-rater agreement among the three coders is 0.67, which indicated a good strength of agreement in finalizing this set of heuristics. Individual inter-rater agreement rate for each heuristic is also computed and reported in Appendix A. Since there are more than two coders in this study, we have adopted a technique (Green, 1997) to compute Fleiss’ kappa to assess concordance among three coders.

It is noted that the number of online game reviews supporting a specific playability heuristic ranges from 41 to 13,604. Although some of these numbers might seem small in comparison to the total amount of reviews analyzed, they must be appropriately viewed in their particular contexts. All of the reviews were targeted on one computer game title and the total number of reviews for a game title could be very small due to its popularity. Some playability heuristics have been aimed at a genre of games that are distinctive. Nevertheless, the factor analysis in the lexical analysis has statistically substantiated the lexicon patterns from which playability heuristics are derived. For example, PB#31 acknowledges that “pass-and-play” is a popular form of board-games that are useful in a cooperative game play setting. It also encourages designers to consider controller-oriented screens for showing unique content to each

player during their turn. Although this heuristic does not receive as many supporting reviews as others, given the trend of playing pass-and-play board games on mobile and tablet devices nowadays, we believe its potential value will be soon recognized.

5. Results and Discussions

The lexical analysis of nouns and adjectives produced 90 playability heuristics. All of these heuristics have been verified and are supported by original reviews. As shown in Table 3, 37 of these playability heuristics replicate the findings from a-priori studies (Desurvire & Wiberg, 2009; Federoff, 2002; Korhonen & Koivisto, 2006; Malone, 1981; Pinelle et al., 2008). For instance, a familiar rule, “the interface should be as non-intrusive as possible,” which is a well-received UI design principle, has been discussed before under the scope of game interface (Federoff, 2002). Factor 20 and Factor 26 de-facto echo this rule by specifying how to present game notifications and design smooth game controls. Factor 51 helps us find a heuristic about character likability in game stories. As the result of examining original player reviews, the heuristic PB#43 was formed as “Humor is highly desirable in most game and is congruent with a wide array of elements, atmospheres and environments.” Oftentimes, characters’ likability is important for certain of games. This is evidenced by PB#37 that advocates emulating real physicality and personality from famous athletes in sport games. A similar rule was accepted into a final heuristic set after large-scale survey studies (Desurvire & Wiberg, 2009). The replication of 37 heuristics suggests that our findings are consistent with prior research and that the heuristics identified in this study are valid.

A number of 53 heuristics are newly discovered. This study substantially extends the pool of playability heuristics that have practical values. Since these rules were developed based on a significant amount of player reviews with a wide spectrum of computer games, they were able to cover many aspects of game play that have never been discerned in past research. For example, PB#59 advises game developers to incorporate more connectivity features to support multiplayer mode. To further enrich multi-PX, PB#32 recommends utilizing social interactions within gaming events. This becomes more demanding given the recent trend of mobile games in the era of social media, especially in a collocated setting. On the other hand, a couple of new heuristics may have been inexplicitly mentioned before, but they are much more elaborated this time. One example is about replayability. Although Federoff (2002) has called for producing re-playable games, there is a lack of detail on how to achieve good replayability. This study was able to produce a heuristic that covered five major dimensions of re-playability. Each of them signals a specific strategy to improve replayability.

Table 3. Statistics about playability heuristics.

Main category	Number of replicated heuristics	Number of new heuristics
Usability	10	14
Playability	25	34
Creativity	2	5
Subtotal	37	53

The class of usability has introduced many new items that are unavailable from the usability heuristics (Nielsen, 1994) for evaluating productivity software. For instance, UB#13 emphasized the efficiency of saving and loading games. It may sound trivial, but prolonged waiting time may adversely affect PX. UB#16 clearly targets at the feedback design for motion-based exercise games. Different from traditional software interfaces, this may not only refer to textual feedback but also gesture and/or vocal cues. Since an avatar is the only character in this kind of games, accurate and meaningful avatar feedback is important in terms of maintaining players’ attention and interest.

The size of creativity category may be small, but it still covers critical insights. For instance, CT#1 reminds us of the idea of balanced game design when introducing novel elements. CT#2 restates the unpredictability as one of the essential design techniques. Freestyling (i.e., CT#5) on the player side is probably equally important as it indirectly represents the degree of creativity.

Due to the tendency for artists to entertain their creative visions, our playability heuristics wanted to preserve some level of specifics. Although certain playability researchers favored a short list, we maintained that more specific heuristics are easier to use and are less likely misinterpreted, especially for those who seek just enough distinctions to bypass the styles of mainstream genres. Because these playability heuristics were extracted from direct player opinions, the specifics in the heuristics are user-oriented and will no doubt be more helpful to game designers and/or developers.

Overall, the discovery of the 90 playability heuristics indicated that the revised lexical approach is effective and valid. By combining nouns and adjectives, the lexical analysis lead to discovery of lexicon patterns that contain specific contextual information. These patterns can then be used to develop valid playability heuristics. To summarize, the main advantages of the playability heuristics developed in this study include the following: (1) They are established by a large number of online reviews and they truly represent player views on computer games. (2) They are based on the most critical issues in player experience since only the factors accounting for the most variances would be able to emerge from the factor analysis. (3) They provide much-needed specifics that cannot be easily derived from general design heuristics or theories. (4) They are comprehensive. These playability heuristics encompass a wide spectrum of computer games and different play scenarios. (5) The playability heuristics are expressed primarily by player language. They are easier to comprehend for game developers who are often players.

6. Conclusions

This study employed a revised lexical approach to analyze nouns and adjectives from over 800,000 online game reviews. As a result, 90 playability heuristics were developed. While these playability heuristics provide much-needed details to game designers and/or developers, they also cover a great range of topics about computer games. These playability heuristics can serve as useful design guidelines for different types of games. They clearly demonstrate the practical contributions of this

study. When combining nouns and adjectives together, the revised lexical approach can be used to discern the most important patterns in UX of a system or product with rich contextual information. These patterns can then be used to establish guidelines of a system or product design. This new approach can be easily extended to other fields for analyzing large amount of online reviews on any system or product. This unique approach equips qualitative researchers with a rigorous, quantitative, and more controllable solution to analyze large amount of user-generated content. Its implications to the field of HCI and IS in general are profound.

Nevertheless, this study has its limitations, as any other study would have. Although the playability heuristics proposed so far are all supported and verified by empirical user reviews, some potential heuristics might have been overlooked due to subjective interpretation of lexicon patterns and new development of game technologies. As in the future, to serve the game industry that never rests, we plan to invite industrial professionals to assess our playability heuristics and continue to refine existing heuristics and introduce new heuristics. The reviews we examined cover computer games released in the last three decades up to the year of 2012. Although it is a fairly large collection, game developers constantly look for changes based on what they learn from existing products in the market and available technologies at the present time. By collaborating with experts in the field, we hope to make the heuristics readily usable when designers are tackling intricate design problems. For instance, CT#1 voices the idea that game designers should find the right blend of novelty and familiarity. This insight attempts to build a bridge between the past and the future in the life cycle of a game product, particularly a long-running game series. It would be great to gather details from experienced designers on how to build this bridge to deliver desired PX. Meanwhile, we also plan to identify the best categories of games for each playability heuristics in order to maximize the value of this set. It appears to us that certain games require a unique set of design principles. For instance, user feedback in sports games focuses on providing accurate statistics, keeping players motivated, etc. If there is such an index that suggested the level of applicability of a heuristic for a group of similar games, it will surely make our playability heuristics more designer friendly.

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Appendix A. Final Set of Playability Heuristics

ID	Main category	Playability heuristic rule	Number of supporting reviews	Inter-rater agreement (Fleiss' Kappa)
CT#1	Creativity	Game players appreciate novelty and designers should try to find the right blend of novelty and familiarity	181	1.00
CT#2	Creativity	The game play elements (e.g., story, tasks) may be unpredictable so it can maintain user curiosity and interest	1004	1.00
CT#3	Creativity	Graphic shading/rendering techniques should help achieve creative goals. For instance, in racing or sports, non-realism character design, such as of cel-shaded cartoon style may attract more players	1894	0.50
CT#4	Creativity	Physics should be appropriate for the setting and mechanics. Sometimes it doesn't need to obey the laws of the real world, but it should be consistent and understandable	101	0.50
CT#5	Creativity	The game should empower the players with more creative freestyle features	296	1.00
CT#6	Creativity	Game play components should not be observed as over-used in the game	118	0.50
CT#7	Creativity	Overly familiar game elements can be perceived as novel and trendy when controlled with gestures	235	0.50
PB#1	Playability	Sports games should provide players with options for camera angles and viewpoints	1060	0.50
PB#2	Playability	Games should provide players with rich, varied statistics and analyses when appropriate. However, designers should strive to find a balance offering rich statistics and overwhelming players with information	169	1.00
PB#3	Playability	The lip movement needs to be correctly synchronized to voice-acting	465	0.50
PB#4	Playability	Players desire extensive customization features in many contexts. For example, the character customization modes should allow for players to define the appearance of characters as well as variety of variables	2137	1.00
PB#5	Playability	Designers should strive to include a variety of elements and features for players to explore and manipulate	4425	1.00
PB#6	Playability	In certain games, users expect to see realistic representations of real-life characters such as athletes	2654	1.00
PB#7	Playability	Non-player characters should be realistic and useful to facilitate game play	106	1.00
PB#8	Playability	Art should facilitate storytelling with a goal of immersing users to achieve harmonious design	1467	0.50
PB#9	Playability	Replayability is most strongly supported by an abundance of features. These also include multiplayer gaming, constant update, and the support of customization	709	1.00
PB#10	Playability	Diversifying multiplayer mode (e.g., "Eight-player") may help keep user interest thus improve re-play value	238	1.00
PB#11	Playability	Multiplayer games should support various strategies and styles of play	1550	0.50
PB#12	Playability	Tension should be engendered through a combination of mechanics and environment but designers should be aware of crossing the line into frustration or burning players out	296	1.00
PB#13	Playability	Art design in game should help promote presence, immersion and player engagement	407	0.50
PB#14	Playability	A balanced gameplay should not over-power any elements (e.g., weapon) so players have difficulty in finishing the tasks	190	1.00
PB#15	Playability	Maneuverability should be balanced in order to maintain relative balance/parity or provide greater value in higher level game assets	414	1.00
PB#16	Playability	Artificial intelligence should seamlessly simulate the behavior of a human player	191	0.50
PB#17	Playability	Statistics, such as those related to characters or actions, should be meaningful and communicated in understandable, satisfying, and simple ways	304	1.00
PB#18	Playability	Lifelike subtleties in character appearance (hair, skin tone, and clothing) and movement (blinking, gait) have a profound effect on perceived realism	1734	1.00
PB#19	Playability	Users desire to create and customize own contents (e.g., playlist)	350	1.00
PB#20	Playability	Team-based multiplayer game modes should emphasize cooperation through adding incentives and creative mechanics	765	0.50
PB#21	Playability	The game environment must be comfortable to view and help present the story	891	1.00
PB#22	Playability	Exaggerated, cartoon-like visuals can increase appeal to children players	106	1.00
PB#23	Playability	Side quests are highly desirable and should provide suitable challenge as well as non-trivial outcomes and rewards	551	1.00
PB#24	Playability	Level grinding should be sufficiently arduous so as to facilitate a sense of accomplishment when new levels are reached but not so tedious that players become frustrated	208	0.50
PB#25	Playability	The sound should correctly interact with the visual to immerse users in the atmosphere of the game	889	0.50
PB#26	Playability	There are multiple forms and methods (e.g., character, cut-scene) through which the game's story is presented	1860	1.00
PB#27	Playability	Any artistic elements (e.g., animation, sound) to be added should fit the game specifically	179	1.00
PB#28	Playability	Actions should result in sensible outcomes that increase the player understanding of the game mechanics and environment	684	0.50
PB#29	Playability	The game storylines should make sense to players	6569	1.00
PB#30	Playability	Pick-up-and-play features is useful for mobile and/or multiplayer party games	108	0.50
PB#31	Playability	Pass-and-play is useful for board-game style multiplayer gaming. The play experience can be augmented by controller-specific screens that can show unique content to each player during their turn	41	0.50
PB#32	Playability	A goal of multiplayer gaming should be to emphasize social interactions and discovery for its own sake	244	0.50
PB#33	Playability	Game-play mode (e.g., local multiplayer) should be functionally compatible with console modules (e.g., WIFI, camera)	92	0.50
PB#34	Playability	High-quality pre-match presentations can help engage player	51	1.00
PB#35	Playability	Virtual artifacts, such as in-game sports memorabilia, can be effective, satisfying, and rewarding	1642	1.00

(Continued)

(Continued).

ID	Main category	Playability heuristic rule	Number of supporting reviews	Inter-rater agreement (Fleiss' Kappa)
PB#36	Playability	A game should have rich features such as various game modes and unique challenge/rewards	1624	1.00
PB#37	Playability	In sports games, emulating real physicality and personality of famous players may entertain the players who like/love them	2532	0.50
PB#38	Playability	Players should be able to alter the default settings (e.g., control setting) to support own play styles	3463	0.50
PB#39	Playability	Context-sensitivity can be used to make games more accessible or to reduce the steps necessary to complete repeated tasks	225	0.50
PB#40	Playability	The assigned tasks should result in well-balanced play and user activities	7602	1.00
PB#41	Playability	The A.I. of a game is perceived useful for accomplishing tasks	299	1.00
PB#42	Playability	The game should allow users to rematch and/or replay at any point	642	0.50
PB#43	Playability	Humor is highly desirable in most game and is congruent with a wide array of elements, atmospheres, and environments	4815	1.00
PB#44	Playability	If the game story takes place in a real city or area, a realistic environment design in the game may gain players unsurpassed commendation	790	0.50
PB#45	Playability	Classic control scheme may still be wanted in new games of a classic category, as players may expect specific control schemes in given genres and/or subgenres	1535	0.50
PB#46	Playability	Accurate game mechanism such as collision-detection is necessary to sustain player satisfaction, especially in online multiplayer gaming	406	0.50
PB#47	Playability	Overt encouragement is desirable in motion-based exercise games	265	1.00
PB#48	Playability	Design and arrangement of intended movement should be reasonable in motion-controlled dance games	164	0.50
PB#49	Playability	Rhythm-based games should have responsive controls and meaningfully express player actions	99	0.50
PB#50	Playability	Players enjoy the games with good storyline that is moderated by multiplayer features	102	0.50
PB#51	Playability	The game A.I. should be perceived as "clever" to evoke a sense of being challenged for players of different levels	299	0.50
PB#52	Playability	Level or location-specific challenges foster exploration, satisfaction/accomplishment and thus replayability	3029	0.50
PB#53	Playability	The ease and efficiency of controlled movement can be altered by adjusting character level and equipped items, etc.	47	0.50
PB#54	Playability	The game may allow players to replay using different characters in the game	4419	1.00
PB#55	Playability	The game should carefully heightened and maintained user emotion/sensation by deliberately arranging the tasks at each level	78	1.00
PB#56	Playability	Players desire a high degree of freedom of movement, exploration, and tactics	4910	1.00
PB#57	Playability	Controls should be as easy to learn without compromising schemes for more complex gameplay	13,604	1.00
PB#58	Playability	Linear game play may lead to user boredom	739	0.50
PB#59	Playability	A game should have more connectivity capability to support multiplayer-related features	1450	1.00
UB#1	Usability	The capacity for customization of game elements is generally desirable and the game may give instructions or self-design features on how to customize its gameplay	645	1.00
UB#2	Usability	Players expect reliable and consistent physics that correctly corresponds to the setting and tone	281	0.50
UB#3	Usability	Games should simplify controls and sometimes provide instant learnability	1224	0.50
UB#4	Usability	Notifications can take a variety of forms and can be expressed through a variety of narrative devices and/or mechanisms. However, they should be properly positioned on the screen so users can notice it immediately, but they should not intrude game-play	162	1.00
UB#5	Usability	Peripherals should be designed with ergonomics, safety, and reasonable levels of accessibility in mind	406	0.50
UB#6	Usability	Game control should allow a smooth gaming experience without unnecessary pauses	265	0.50
UB#7	Usability	Users can safely save their progress at any states; The availability of game saving may affect challenge/difficulty	120	1.00
UB#8	Usability	For the same game, controls must be consistently functional across multiple platforms to ensure the same playfulness	912	0.50
UB#9	Usability	Keypad design, which allows players to input data or control the game, should be user-friendly. For example, the design of the keypad should be accommodated to hand/finger sizes of game players	115	0.50
UB#10	Usability	Maps in the game should be easy to navigate, interpret, and manipulate and should correspond closely to player mental models for game environments	607	1.00
UB#11	Usability	UI elements (e.g., cursor) may be deliberately designed to provide feedback on certain game operations (e.g., user status)	112	0.50
UB#12	Usability	Game UI should reasonably respond to user actions	385	0.50
UB#13	Usability	The time spent on loading and/or saving game should be minimized, as it may impact enjoyment of game-playing	591	0.50
UB#14	Usability	Content-wise, a game should be error-free (e.g., typo)	112	0.50
UB#15	Usability	Calibrating settings and specialized controllers should be efficient and understandable	146	1.00
UB#16	Usability	Accurate, real-time feedback through avatar is highly desirable in motion-based exercise games	129	1.00
UB#17	Usability	The default camera angles should provide unobstructed views that are appropriate so not to affect game playing	150	0.50
UB#18	Usability	Users should be able to see distant objects at a stable frame-rate and the game should allow players to customize the draw distance to balance the game performance and visuals	118	1.00
UB#19	Usability	Design of game control scheme needs to provide conveniences to players	407	0.50
UB#20	Usability	Players can quickly save a game with a single input so as to not disrupt game play	112	1.00
UB#21	Usability	In-game tools and menus should be usable in the manner as any other productivity application	77	1.00
UB#22	Usability	Control systems should respond to user actions accurately especially mapped through external devices/units	266	0.50
UB#23	Usability	Players may expect auto-save features at certain points especially after cut-scenes and boss fights	197	1.00
UB#24	Usability	Control mechanisms should be consistent in different gaming events	1121	0.50

Appendix B. Factor Loading of Selected Terms for Developing Playability Heuristics

Factors	Terms	Heuristics	Factor loadings
2	Next-generation, Unprecedented Next-gen	Game players appreciate novelty and designers should try to find the right blend of novelty and familiarity	Unprecedented: 0.22472 Next-generation: 0.18419 Next-gen: 0.09958
2	Revolutionary User-generated Custom Customized	The capacity for customization of game elements is generally desirable and the game may give instructions or self-design features on how to customize its gameplay	Revolutionary: 0.09084 Custom, Customized: 0.11003 User-generated: 0.04482
4	Predicted	The game play elements (e.g., story, tasks) may be unpredictable so it can maintain user curiosity and interest	Predicted: 0.0153
5	Broadcast-style	Sports games should provide players with options for camera angles and viewpoints	Broadcast-style: 0.07531
5	Statistical	Games should provide players with rich, varied statistics, and analyses when appropriate. However, designers should strive to find a balance offering rich statistics and overwhelming players with information	Statistical: 0.14049
6	Physics	Players expect reliable and consistent physics that correctly corresponds to the setting and tone	Physics: 0.05392
6	Audible	The lip movement needs to be correctly synchronized to voice-acting	Audible: 0.19315
6	Create-a-team	Sports games should allow players to create a new team	Create-a-team: 0.08508
7	Feature-rich	Designers should strive to include a variety of elements and features for players to explore and manipulate	Feature-rich: 0.05398
7	Player-specific	In certain games, users expect to see realistic representations of real-life characters such as athletes	Player-specific: 0.07481
7	Create-a-player	Players desire extensive player-character customization in many contexts and character customization modes should allow for players to define the appearance of characters as well as variety of variables	Create-a-player: 0.09171
8	Magic Magical Charming Wizard	Art should facilitate storytelling with a goal of immersing users to achieve harmonious design	Magic, magical, charming, wizard: 0.30936
8	Non-players	Non-player characters should be realistic and useful to facilitate game-play	Non-player: 0.10049
9	Re-playability	Replayability is most strongly supported by an abundance of features. These also include multiplayer gaming, constant update, and the support of customization	Storyline: 0.16395 Graphics-wise: 0.06222 Multiplayer-focused: 0.06728 Re-playability: 0.03279 Replay-ability: 0.01211 Re-playable: 0.01711 Re-read: 0.00525
10	Four-player Eight-player Addition	Diversifying multiplayer mode (e.g., "Eight-player") may help keep user interest thus improve replay value	Eight-player: 0.33733 Four-player: 0.14469 Addition: 0.0959
11	Run-and-gun	Multiplayer games should support various strategies and styles of play	Run-and-gun: 0.07661
12	Horror Scary Chilling Ambiance Ambience Atmosphere Psychological Sound-track	Art design in game should help promote presence, immersion and player's engagement	Horror: 0.40015 Scary chilling: 0.30245 Ambiance, ambience, atmosphere: 0.25477 Sound-track: 0.02239 Psychological: 0.20495
12	Tension	Tension should be engendered through a combination of mechanics and environment but designers should be aware of crossing the line into frustration or burning players out	Tension: 0.16913 Anxiety: 0.09948
14	Create-a-wrestler	The game should provide customer design-ability features/options to amaze the players	Create-a-wrestler: 0.2305
15	Area-effect	A balanced gameplay should not over-power any elements (e.g., weapon) so players have difficulty in finishing the tasks	Area-effect: 0.30392 Compensation: 0.05936
16	Instant-action	Games should simply controls and sometimes provide instant learnability	Instant-action: 0.09405
16	Autopilot	The game's auto-features, if there are any, should be intelligent and consistent	Autopilot: 0.1467
16	Maneuverability	Maneuverability should be balanced in order to maintain relative equipment balance/parity or provide greater value in higher-level equipment	Maneuverability: 0.09236
17	Versatility	The game may offer characters with more task/growth versatility embedded in the game story to satisfy the players' needs	Versatility: 0.12747
17	AI-controlled	Artificial intelligence should seamlessly simulate the behavior of a human player	AI-controlled: 0.13107
17	Statistic	Statistics, such as those related to characters or actions, should be meaningful and communicated in understandable, satisfying, and simple ways	Statistic: 0.08832
20	Notification	Notifications can take a variety of forms and can be expressed through a variety of narrative devices and/or mechanisms. However, they should be properly positioned on the screen so users can notice it immediately, but they should not intrude game-play	Notification: 0.10026
21	Lifelike	Lifelike subtleties in character appearance (hair, skin tone, and clothing) and movement (blinking, gait) have a profound effect on perceived realism	Lifelike: 0.08547
22	Peripheral Reliability	Peripherals should be designed with ergonomics, safety, and reasonable levels of accessibility in mind	Peripheral: 0.06374 Reliability: 0.05048
22	Playlist	Users desire to create and customize own contents (e.g., playlist)	Playlist: 0.04759
26	Team-based Teamwork	Team-based multiplayer game modes should emphasize cooperation through satisfying incentives and creative mechanics	Team-based: 0.09983 Teamwork: 0.08719
26	Team-oriented Faster-paced	Game control should allow a smooth gaming experience without unnecessary pauses	Team-oriented: 0.03735 Faster-paced: 0.03022

(Continued)

(Continued).

Factors	Terms	Heuristics	Factor loadings
26	Save-game	Users can safely save their progress at any states; the availability of game saving affects challenge/difficulty	Save-game: 0.05307
26	Well-presented	The game environment must be comfortable to view and the story should be well-presented.	Well-presented: 0.03717
27	Kid-friendly	Exaggerated, cartoon-like visuals can increase appeal to children	Kid-friendly: 0.05969
30	Cuteness		Cuteness: 0.05618
30	Keypad	Keypad design, which allows players to input data or control the game, should be user-friendly. For example, the design of the keypad should be accommodated to different hand/finger sizes of game players	Keypad: 0.05379
30	Multi-platform	For the same game, controls must be consistently functional across multiple platforms to ensure the same playfulness	Multi-platform: 0.01935
31	Cel-shaded	For some games, like racing or sports, non-realism character design, such as of cel-shaded cartoon style may attract more players	Cel-shaded: 0.08298
	Cel-shading		Anime-inspired: 0.06962
	Anime-Inspired		Cel-shading: 0.06435
31	Level-grinding	Level grinding should be sufficiently arduous so as to facilitate a sense of accomplishment when new levels are reached but not so tedious that players become frustrated	Level-grinding: 0.0506
31	Side-quest	Side quests are highly desirable and should provide suitable challenge as well as non-trivial outcomes and rewards	Side-quests: 0.08356
32	Side-quests		Side-quest: 0.04169
32	Physics-based	Physics should be appropriate for setting and mechanics. Sometimes it doesn't need to obey the laws of the real world, but it should be consistent and understandable	Physics-based: 0.06369
32	Dreamy	The sound should correctly interact with the visual to immerse users in the atmosphere of the game	Dreamy: 0.05826
32	Storybook	There are multiple forms and methods (e.g., character, cut-scene) through which the game's story is presented	Storybook: 0.0702
32	Cartoon-style	The added artistic element (e.g., animation, sound) should fit the game specifically	Cartoon-style: 0.01833
33	Mid-range	The games should be designed and tested with a good compatibility and consistency with different monitor resolutions and frame-rates	Mid-range: 0.11821
33	Risk-versus-reward	Actions should result in understandable outcomes that increase the player understanding of the game mechanics and environment	Risk-versus-reward: 0.09317
34	Story-line	The game storylines should make sense to players	Story-lines: 0.02311
36	Pick-up-and-play	Pick up and play is useful for mobile and/or multiplayer party games	Pick-up-and-play: 0.05634
36	Pass-and-play	Pass-and-play is useful for board-game style multiplayer gaming. The play experience can be augmented by controller-specific screens that can show unique content to each player during their turn	Pass-and-play: 0.03784
36	Compatibility	Game-play mode (e.g., local multiplayer) should be functionally compatible with console modules (e.g., WIFI, camera)	Compatibility: 0.02848
36	Connection	A goal of multiplayer gaming should be to emphasize social interaction and discovery for its own sake	Connection: 0.15561
36	Easy-to-navigate	Maps in the game should be easy to navigate, interpret and manipulate and should correspond closely to player mental models for game environments	Easy-to-navigate: 0.02502
37	Power-ups	UI elements (e.g., cursor) may be deliberately designed to provide feedback on certain game operations (e.g., user status)	Power-ups: 0.16128
39	Physicality	In sports games, real physicality and personality of famous players may entertain the players who like/love them	Physicality: 0.25455
39	Likelihood	Players should be able to alter the default settings (e.g., control setting) to support own play styles	Likelihood: 0.05402
39	Pre-match	High-quality pre-match presentations can help engage players	Pre-match: 0.11321
	Memorabilia	Virtual artifacts, such as in-game sports memorabilia, can be effective, satisfying and rewarding	Memorabilia: 0.0322
39	Feature-packed	A game should have many features such as various game modes and unique challenge/rewards	Feature-packed: 0.11223
40	Orientation	Camera angle and orientation should be responsive and adaptable so as to not occlude any important game action from player view	Orientation: 0.07858
45	Context-sensitive	Context-sensitivity can be used to make games more accessible or to reduce the steps necessary to complete repeated tasks	Context-sensitive: 0.10277
45	Puzzle-solving	The assigned tasks should result in well-balanced play and user activities	Puzzle-solving: 0.12709
46	Intelligence-controlled	The A.I. of a game is perceived useful for accomplishing tasks	Intelligence-controlled: 0.06916
47	Well-written	There should be meaningful character dialogues in a well-crafted narrative	Well-written: 0.05833
48	Rematch	The game should allow users to rematch and/or replay at any point	Rematch: 0.03939
48	Create-a-fighter	Empower players with more game design options, such as providing various customization features in a character's creation, or offer character's learning ability feature	Create-a-fighter: 0.07968
51	Motion-control	Motion controls should attempt to mimic the physical action being simulated in the game	Motion-controlled: 0.0259
51	Tongue-in-cheek	Humor is highly desirable in most game and is congruent with a wide array of elements, atmospheres and environments	Tongue-in-cheek: 0.13383
53	Disconcerting	Game UI should appropriately respond to user actions	Disconcerting: 0.23637
53	Unsurpassed	If the game story takes place in a real city or area, a realistic view design in the game may gain players unsurpassed commendation	Unsurpassed: 0.22128
54	Two-button	Classic control scheme may still be wanted in new games of a classic category	Two-button: 0.08039
56	Action-based	The time spent on loading and/or saving game should be minimized, as it may impact enjoyment of game-playing	Action-based: 0.03488
56	Collision-detection	Accurate collision-detection is necessary to sustain player satisfaction, especially in online multiplayer gaming	Collision-detection: 0.02793
57	Typo	Content-wise, a game should be error-free (e.g., typo)	Typo: 0.01322
60	Choreography	Design and arrangement of intended movement should be reasonable in motion-controlled dance games	Choreography: 0.07499
60	Encouragement	Overt encouragement is desirable in motion-based exercise games	Encouragement: 0.10119
60	Measurement	Accurate, real-time feedback such as avatar movement is highly desirable in motion-based exercise games	Measurement: 0.07495
	Feedback		Feedback: 0.0737
60	Calibration	Calibrating settings and specialized controllers should be efficient and understandable	Calibration: 0.03954
61	Three-click	Players come to expect specific control schemes in given genres and/or subgenres	Three-click: 0.22496

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Factors	Terms	Heuristics	Factor loadings
61	Create-a-character	Users can craft own characters and associated features with options	Create-a-character: 0.09577
63	Rhythm-based	Rhythm-based games should have responsive controls and meaningfully express player actions	Rhythm-based: 0.04411
63	Freestyle	The game should empower the players with more creative freestyle features	Freestyle: 0.18725
64	Jump-in		Jump-in: 0.11656
64	Cleverness	The game A.I. should be perceived as “clever” to evoke a sense of being challenged for players of different levels	Cleverness ingenuity: 0.06203
64	Moderator	Players enjoy the games with good storyline and moderated multiplayer feature	Moderator: 0.0238
66	Zoomed-in	The default camera angles should provide unobstructed views that are appropriate so not to affect game playing	Zoomed-in: 0.05342
70	Level-specific	Level or location-specific challenges foster exploration, satisfaction/accomplishment and thus replayability	Level-specific: 0.08153
70	Location-specific		Location-specific: 0.04279
70	Create-a-skater	Users can craft own characters and associated features with options	Create-a-skater: 0.10058
70	Draw-in	Users should be able to see distant objects at a stable frame-rate and the game should allow players to customize the draw distance to balance the game performance and visuals	Draw-in: 0.08947
71	Agility	The ease and efficiency of controlled movement can be altered by things like character level and equipped items	Agility: 0.07664
74	Non-sense	The game story-lines should be logically sensible to users	Non-sense: 0.00976
74	Replay-value	The game may allow players to reply using different characters in the game	Re-used: 0.03113
	Re-use, Re-play		Replay-value: 0.3061
	Movie-to-game		Re-play: 0.11617
			Movie-to-game: 0.05975
76	Straight-up	Design of game control scheme needs to be convenient to players	Straight-up: 0.07457
80	Heart-racing	The game should carefully heightened and maintained user emotion/sensation by deliberately arranging the tasks at each level	Heart-racing: 0.27652
81	Quick-save	Players can quickly save a game with a single input so as to not disrupt game play	Quick-save: 0.0789
81	Openness	Players desire a high degree of freedom of movement, exploration and tactics	Openness: 0.03401
82	Over-used	Game play components should not be observed as over-used in the game	Over-used: 0.03256
82	Easy-to-learn	Controls should be as easy to learn without compromising schemes for more complex gameplay	Easy-to-learn: 0.12745
82	Easy-to-use	In-game tools and menus should be usable in the manner as any other productivity application	Easy-to-use: 0.06458
82	Over-powered	Designers should take care to avoid offering items, weapons, spells, abilities, etc. that can be unreasonably/unstoppably powerful; either on their own or in some configuration	Over-powered: 0.04709
84	Pixel-perfect	Control systems should respond to user actions accurately especially mapped through external devices/units	Pixel-perfect: 0.14187
84	Motion-sensing	Overly familiar game elements can be perceived as novel and trendy when controlled with gestures, which is the trend in game design	Motion-sensing: 0.08454
	Gesture-based		Gesture-based: 0.03263
88	Play-through	Linear game play may lead to user boredom	Play-through: 0.09246
88	Auto-save	Players may expect auto-save features at certain points especially after cut-scenes and boss fights	Auto-save: 0.03581
89	Button-pressing	Control mechanisms should be consistent in different gaming events	Button-pressing: 0.08277
90	Connectivity	A game should have more connectivity capability to enable multiplayer-related features	Connectivity: 0.14746
97	Not-so-subtle	The game story-lines should be logically sensible to players	Not-so-subtle: 0.04122