The Game Genre Map: A Revised Game Classification

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ABSTRACT
The existing common video game genres lack clarity as well as consistency and thus cannot serve as a solid reference to inform the research on digital educational games (DEG), which are increasingly used as learning tools. To address this basic issue of game classification, we have developed a web-based survey to collect data on how people play and perceive video games that they know well. The survey is grounded in our Game Elements-Attributes Model (GEAM). 321 valid responses were analysed using established hierarchical clustering methods and a novel mapping technique that computes the degree of relevance of individual game attributes to game types and visualises them with hues of grey. The game genre map so obtained can improve the existing game classification.

Author Keywords
Digital games; game genre; hierarchical clustering; mapping

ACM Classification Keywords
K.8.0; H.5.m; J.m; K.3.m

INTRODUCTION

To research the potential of digital educational games (DEG), one basic approach is to study existing digital entertainment games in order to identify which kinds of games are most beneficial for learning specific educational content. As a game with an educational purpose, a DEG should address both the pedagogical and game design aspect, which should draw on the same mechanisms of entertainment games. When deciding which kind of game to use for teaching a certain topic, a DEG designer should consider different options to identify the most promising solution. However, the number of existing digital games is far too big to be considered individually. This decision-making process can be facilitated with a well-defined game classification system, which groups similar games by a set of attributes they share. These sets of attributes can then be researched on their suitability for DEGs on specific topics.

The generally accepted and widely used classification system for games is game genres. However, their definitions are diverse and inconsistent as observed by reviewing different sources [11, 14, 28, 31]. While this 'chaotic' situation has existed perhaps since the inception of the video game industry and research in the early 1970s [19], research efforts in analysing such divergences and in harmonizing them are rather limited (e.g., [2, 7, 22]), and results thereof remain inconsequential.

To address this foundational issue on game classification, which can have broad impacts on game research and game industry, we have been motivated to design and conduct a web-based questionnaire entitled "Game Classification Survey". Overall, what we aimed to achieve is to refine the existing game genres and to inform the research on DEGs by basing the genre definitions on a comprehensive model called Game Element-Attribute Model (GEAM) [17]. By creatively deploying a mapping technique we visualise the relations between game genres.

CLASSIFICATION OF GAMES

Classification of games is a frequently discussed topic in game research [1, 3, 31]. In this section we present an overview of existing classification systems. First of all, it is necessary to differentiate four related terms: 'game type', 'game genre', 'game class' and 'game classification'.

Clarifying Terms

Several attempts have been undertaken with the aim of differentiating the aforementioned terms. [16] distinguished between 'game genre' and 'game type' by defining the genre as "style of game play" (e.g. Science Fiction) and the type as "the mechanics of gameplay" (e.g. first-person shooter). [18] described 'game genre' as artistic design, and 'game type' as architecture and functionality. In addition, [18] assigned the term 'game class' to the description of player behaviour and experience.

However, in practice the terms 'game type' and 'game genre' seem not to be used as defined, for instance, [15] pointed out that they are sometimes used interchangeably in industry. To identify the prevailing definition of 'game type' in the literature, we have analysed a selection of papers ('game genre' literature will be discussed in the subsequent section). ACM Digital Library (with the option "Publications from ACM and Affiliated Organizations"), given its broad coverage of publications on a diversity of research topics (including games) from different channels, has been searched for the term 'game type', resulting in 200 hits (as of October 2014). Half of the papers were regarded

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as irrelevant for the following reasons: Three papers were not accessible; 21 discussed some unrelated topics, mostly on Game Theory (strategic decision-making); five papers used both words 'game' and 'type', but with no relation; 17 of the papers contained the term 'game-type' instead of 'game type' to refer to something as being a game or game-like; 54 did not provide enough information on the meaning of the term. The remaining papers were analysed for the use of the term 'game type' as well as its relation to similar terms.

The main findings from the remaining 100 papers[1] are:

- Game types define groups of games (only one source [24] is contradicting where individual games such as chess and backgammon instead of groups were listed as examples of game types).
- Game types differentiate games based on one or more characteristics (e.g., cooperative vs. competitive games [27], or keyboard-controlled vs. gaze-controlled games [20]).
- The term 'game type' is often used interchangeably with 'game genre' and 'game class'.
- 'Game type' is sometimes described as if it is subsumed by game genre hierarchically (e.g. "Capture the Flag game type in the first-person shooter" [10])

Hence, game type is a generic term referring to the division of games into groups based on one or multiple criteria. Accordingly, the term can be used at a high level, distinguishing between only two groups of games, separated by a single criterion, but it can also be a surrogate for 'game genre' or used at a low level as sub-genre. A combination of different game types constitutes a game classification.

Game Genres

The most common way of classifying digital games is to divide them into *game genres*. A variety of genre collections can be found in literature (e.g. [4, 21, 23, 28]). [31] even identifies a list of 42 video game genres. A genre is usually defined with a simple description and some sample games. Despite its widespread uses, we have identified several issues with the game genre approach:

- *Genres are not clearly or consistently defined*. One example is Role-play game: While characters and stories are generally considered as important components of this game genre, emphasis is different: [28] described story as more important than character development, and it is vice-versa for [14]. Another example is strategy games that require careful thinking and planning [23]. However, it can be argued that such requirements are also applicable for puzzle or adventure games.
- *The relation between genres is unknown*. Genres are defined individually and attributes used to describe one genre are not mentioned in the description of another. It is unclear how much genres differ and if they overlap. As sometimes a mixture of genres, e.g. Action-adventure is acknowledged as genre on its own, there is a strong indication that overlaps exist and verifying relations would help to understand why some games seem to fit in multiple genres. Especially when categorised by sellers, games are often placed in multiple genres, e.g. in online-stores, to increase the likelihood of being found by the user.
- *Definitions are based on completely different aspects*. This is another issue arising from individual and unrelated definitions of game genres. For example, educational games are sometimes listed as genre (e.g., [31]; Wikipedia; Amazon) while at the same time basically any type of game designed with educational value can be an educational game. So for this genre the defining attribute is its educational value, while for others it may be the dominant action in the game, or the camera perspective (e.g. First-person shooter).
- *Different sources use different sets of genres*. Seven game genres – Action, Strategy, Role-play, Adventure, Puzzle, Sports and Simulation – are commonly referenced in different sources (e.g. [14, 23, 28, 31]; Wikipedia; Amazon; metacritic.com - a game rating website), albeit not unanimously (e.g., Puzzle is not included in [14] or [23]; Simulation is refined as 'Vehicle simulation' in [28] and 'Flight & other simulations' in [14]). There also exist many less common game genres with some being named differently (e.g. Music vs. Rhythm & dance) and some being separated or merged (e.g. Racing & driving; Board, card & casino).

Other Game Classifications

Several authors have expressed a similar concern that the commonly known game genres lack clarity as well as consistency and therefore proposed alternatives. While some are not well justified (e.g. [26]), three approaches give valuable input.

[1] introduced an 'open' model to differentiate games along 15 dimensions with associated values, which are meta-categorized into five groups (i.e., space, time, player structure, control, and rules). This initial model was revised to include two more dimensions, resulting in altogether 17 dimensions grouped into eight meta-categories [12]. With minor amendments the model was used by "three game players with a fair amount of diverse game experience" for categorizing 100 games [6]. Using cluster analysis, four game genres were identified: strategy, first-person shooter, progression & exploration, and perfect information. While basing the classification on a fixed list of differentiating attributes could overcome the issues of the existing classification by game genres, there are still some concerns in the chosen approach. First, the list of attributes was compiled by comparing different games, but it is unclear how comprehensive it is, i.e. if all basic elements of games are considered. Second, the research leading to the identified genre was done by a small team of three experienced players, which could increase the risk of biased results. Thirdly, for the categorisation it was considered that some games have different gameplay modes (e.g. multi- and single-player), but not that the playing style of players can differ (e.g. in "World of Warcraft" one player can

be interested in the story, while another player only tries to level up as fast as possible without following the story). A game may be categorised differently depending on which attributes are deemed important by a player, not just by which attributes it contains. Finally the resulting genres are barely defined and thus not convincing. For instance, the first-person shooter is described by controlling an avatar and a vagrant camera position, but this should also be applicable to some progression & exploration games, which are defined as exploring a story, character or world (e.g. "Skyrim" should fit in both genres). The relations between game genres thus remain unclear.

[22] conducted a more conclusive study, where 124 participants were asked to compare pair-wise a set of ten games by rating their similarity. Using multidimensional scaling (MDS) methods, they identified game clusters. While the approach used in [22] is methodologically stronger than that in [6] where participants were bound to some predefined dimensions and values, a major drawback of such flexibility is that variables had to be derived from clusters subsequently, which mostly is a subjective interpretive process. For game comparisons, it is critical to have a robust set of underlying variables for defining a game and to illustrate how it is similar or different from other games. To analyse the influence of a specific game type on learning efficacy of DEGs a well-defined set of variables is deemed necessary.

Another intriguing approach to game classification is to group them based on rules - a key element of a game. By analysing the rules of 588 video games, [8, 9] extracted a set of ten elementary rules describing the gameplay, which were coined as "game bricks". Then [7] set up a website to invite people to classify games based on game bricks and some other aspects such as purpose, scope, and market. Although the game-brick-based classification approach is systematic, it is inadequate for game comparisons. An obvious drawback is that it tends to reduce game characteristics to a bare minimum as basic rules, thereby missing other critical elements such as story.

Summary

Besides identifying issues in the current game classification, we propose the following definitions based on our findings:

- *game types = groups of games, differentiated based on one or more game characteristics (game class = less often used synonym for game type)*
- *game classification = set of criteria by which games are differentiated*
- *game genres = a subset of game types; in combination game genres form a popular game classification*

REVISING GAME CLASSIFICATION

Given the issues discussed above, we aim to analyse as well as refine the definitions of existing game genres. However, we do not intend to introduce yet another set of terms to aggravate the confusion. If supported by the empirical findings, we aim to retain the names of the genres that are already widely adopted by the game community. The main drawback with the current game genres is that each genre is defined individually. This makes it difficult to compare and identify relations between genres. Being aware of which and how genres overlap is necessary to find a set of genres which represent the full range of different games while achieving maximal separation.

To attain comparability, game types need to be all defined based on the same set of attributes, similar to the approach used in [1]. Unlike [1], we argued that the attributes must be included in a comprehensive game model to ensure that all the game elements are considered and concomitantly developed our *Game Elements-Attributes Model* (GEAM) [17] (Figure 1).

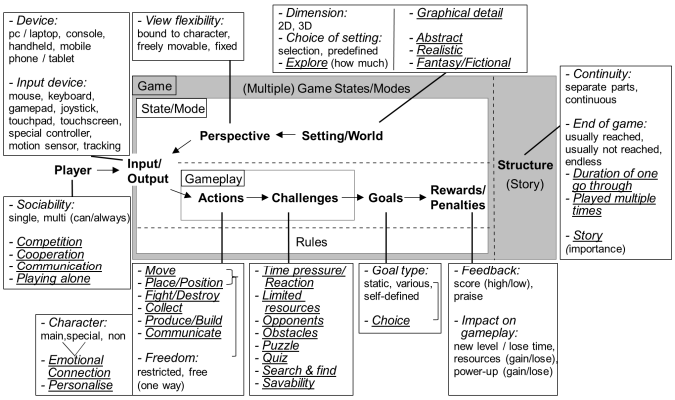

Figure 1: GEAM model, underlined attributes are continuous, others are categorical variables

Analysing the attributes of different games using the GEAM, similar games can then be clustered with the approach as described in [6]. Like [22], we planned to collect empirical data with a survey from a large group of gamers rather than a small group of experienced gamers, thereby enabling us to gain a better understanding of how games are played. We also used the multidimensional scaling methods [22], but not on the individual game level, but the clustered games level, to gain further understanding on the relation of game types. Furthermore, we compared how the derived game types match the gamers' understanding of existing game genre.

In summary, we have identified four requirements for a new or refined game classification that underpins the design of our survey. The four requirements are: (i) To provide a comprehensive set of attributes by associating them with individual elements of a game model, which represents the basic architecture of digital games; (ii) To compile consistent definitions of game types, allowing recognition of relations and comparison of games, by building a new classification upon a set of general game attributes; (iii) To examine whether and how the existing game genres can be mapped onto the new ones; (iv) To take into account the assumption that games are normally played and perceived in various ways by different players.

As the ultimate goal of our planned future research study is to compare the learning quality of different game types for learning specific educational content, it is essential to analyse

how games differ at the componential level. Hence, we have developed our model GEAM [17] of which two critical components are *elements* and *attributes*. As a result of examining game definitions, we identified the core elements of games: player, input/output, actions, challenges, goals, rewards/penalties, game world, perspective, structure. Based on an extensive literature review we then compiled a list of attributes for each game element, representing main options on how these elements can be realised in a game (e.g. the challenges in a game can be puzzles, opponents, time pressure etc.). The main advantage of the GEAM, in comparison to [1], is that it depicts the relations between game attributes and elements, contributing to the GEAM's higher comprehensiveness.

EMPIRICAL STUDY

The main goal of our "Game Classification Survey" (GCS) is to collect data from gamers how they play and perceive video games in order to enhance our understanding of existing game genres. To enhance the readability of the ensuing text, the following conventions are used: A game genre is written in capitals (e.g. ACTION); an element is capitalised (e.g. Actions); an attribute is italicised (e.g. *move*); a game is in quotes (e.g. "WOW", which stands for World of Warcraft).

Survey Design

Grounded in the GEAM, we developed the GCS to derive from the survey data clusters of games sharing a similar set of attributes. Each respondent was asked to select a game from the list given or nominate a game which she knew well. Then she was asked to evaluate the game with respect to individual attributes of each of the elements, using a slider with a range of integers from 0 to 100 for 27 of the 29 continuous variables and fill-in-the-blank for the other two, or using a multiple-choice format for categorical variables. Finally, the respondent was required to assign the game to one (or more) of the seven common genres; she could also provide alternative classification terms.

Genre	Game
Action	*GTA, Angry Birds, Tekken, Call of Duty, Super Mario*
Adventure	*Monkey Island, Myst, Tomb Raider, Prof. Layton, Legend of Zelda*
Puzzle	*Tetris, Pac-man, Dr. Kawashima, Solitaire*, Portal*
Role-play	*Pokemon, Final Fantansy, The Elder Scrolls, World of Warcraft, Diablo*
Simulation	*Nintendogs, Sims, Flight Simulator, FarmVille*, Guitar Hero*
Sports	*Wii Sports, FIFA Soccer, Tony Hawk's, Just Dance, Gran Turismo*
Strategy	*Warcraft, Warzone2001, Command & Conquer, Worms, Anno*

Table 1: Preselected games based on sales figures and genre allocation from VGChartz (2012); *free, highly popular ones

The rationale of providing the respondents with a list of games to choose (though they were still free to nominate one) was to increase the probability that a game would be selected and rated multiple times, enabling us to perform the game clustering. Our critical task was then to identify a list of representative games, which were selected based on sales figures with the intention to include the most popular ones.

Player
How would you rate the importance of the following aspects? (*Competition, Cooperation, Communication, Playing alone*)
Actions
How would you rate the importance of the following action(s) in the game? (*Move, Place/Position, Fight/Destroy, Collect, Produce/Build, Communicate*)
Please rate the importance of the following aspects of the main character (*Emotional connection to the character*; *Personalise the character*)
Challenges
How would you rate the importance of the following challenges in the game? (*Time pressure, Limited resources, Opponents, Obstacles/Forces, Puzzle, Quiz, Search/find, Savability*)
Goals
How free are you to *choose* which goals (missions, tasks or quests) you want to complete?
World/Setting
How would you rate the *level of detail of the graphics* of the game?
How much can you *explore* in the game?
How would you describe the visual appearance of the objects and the environment in the game? - *Abstract* (not a world, but a grid or board) - *Realistic* (similar to real world) - *Fantasy/fictional* (not real)
Structure
How important is the *story* for the game?
**How many times* did you replay the game? [multiple times]
**How long* did it take you to play the game once (pure playtime)? Please state the duration as a range between an approximate minimum and maximum in hours. [duration/range]

Table 2a: The questions for the continuous variables (in italics) * items are measured with numeric input

Goals
How'd you describe the goal(s) that you try to reach in the game? *Static; Various; Self-defined*
Rewards/Penalties
▪ What rewards do you get for reaching a goal in the game? *Access to new levels; Power-ups; High score; Resources; Praise* ▪ How are mistakes made during the gameplay penalised? *Losing time; Losing power-ups; Lower score; Losing resources; No penalty*
Structure
▪ How is the game structured? The game is broken down into *separate parts*; The game does not have separate parts, but is *continuously progressing* ▪ Did you ever finish the game? *Yes, I finished at least once; No*, {different reasons to choose}

Table 2b: Sample questions for the categorical variables

We used the figures posted on the website VGChartz 2012 [29] which is generally considered rather accurate for games available in the market. We also included two free and very popular games. For a balanced distribution, five games were selected for each genre (Table 1). We were well aware of the issue of "multiple categories" or ambiguity in this website (e.g. "Angry Birds" can be found under ACTION,

PUZZLE and STRATEGY), and this is exactly part of the issue we aimed to investigate.

The questions of GCS were structured and formulated with reference to the 9 elements and 42 attributes (29 continuous; 13 categorical) included in GEAM. Due to the space limit, we only present the questions for measuring the continuous variables (Table 2a) and some questions for the categorical variables of the elements Goals, Reward/Penalties, and Structure (Table 2b), as they had higher relevance to the design of DEGs. The full GCS is accessible: http://alturl.com/8mug8.

Participants

The invitation to participate in the survey was disseminated to several mailing lists such as chi-web@acm.org over a period of three months. We have received 560 responses of which 321 were complete and valid for analysis. The age range of the respondents was from 15 to above 51 years old (3%) with the largest group between 21 and 25 (36%); 70% were male. Respondents were from 24 countries worldwide with most of them (73%) residing in Europe. Their game experience varied with 20% being very experienced players who know many different games and play games almost every day; 57% were university students; 35% employees and the rest were high school students, employers or others.

RESULTS

Individual respondents identified a game they were going to analyse. Some games were repeatedly mentioned; consolidating all the games chosen results in 67 different games with 33 of them from the given list (Table 1, except "Dr. Kawashima" and "Nintendogs" which were never chosen). Figure 2 shows the frequencies of the games chosen per existing genres and the 'open' one (i.e. for the games nominated by the respondents).

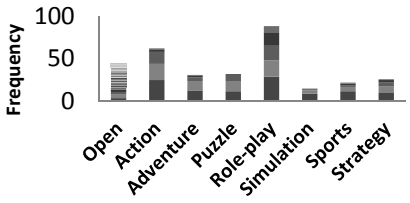

Figure 2: Number of games per given genre and the 'open' one (nominated by respondents)

Hierarchical Clustering

To group the games systematically, cluster analysis was employed. Among different established clustering algorithms, we applied hierarchical clustering (HC) for several reasons: HC does not require a predefined number of clusters, the dendrogram (not shown here) as part of the analysis outcomes, can visualize well the preliminary grouping of the games, and HC was adopted in the related work [6]. Nonetheless, it is generally recognized [25] that clustering does not give highly precise and consistent results, as different algorithms tend to produce somewhat different clusters. Hence, cluster results need to be validated and interpreted based on an expert's understanding of the topic. As HC that can process mixed data efficiently is yet to be established, only the 29 continuous variables (Table 2a) were taken into account as they cover the more important aspects such as gameplay. Normalisation of the data was necessary for the two variables with open numeric input.

With agglomerative HC, cases are grouped together based on a similarity matrix with either distance or correlation for each pair of cases. To validate the consistency of the clustering results, different distance measurement methods can be used [25]. As some methods are (too) sensitive to outliers such as single and complete linkage and some such as Ward's method tend to build equally sized clusters (which is irrelevant to our work), we opted for the more robust methods listed in Table 3. The metrics were computed using SPSS v.19.0. The 1st method identified 14 clusters whereas the 2nd and 3rd found 16; the additional ones resulted from the splitting of two of the clusters. The average overlap rate (i.e. a cluster is identified by all three methods) was 61%, which we considered as a reasonable consistency level (Note: no recommended acceptance rate is given in the literature [25]). Hence, the 16 clusters were used for subsequent analyses.

ID	Method	Metric
1st	Average linkage between groups	Euclidean distance
2nd	Average linkage within groups	Euclidean distance
3rd	Centroid	Pearson correlation

Table 3: Hierarchical methods used to analyse the game data

Spatial Maps with Multi-dimensional Scaling

To understand how the 16 clusters were related to each other, we created a two-dimension (2D) map to visualize their similarity. Clusters sharing a similar set of attributes should be placed close to each other. The visual cues of proximity support genre identification. Whereas a genre can comprise more than one cluster, an overlap of clusters can result in a mixed genre. To calculate the distances between the clusters, ANOVA was conducted for the 29 continuous variables (i.e. game attributes). Results indicated that three attributes – *playing alone, quiz* and *savability* - had low significance and were thus discarded. This finding on *savability* is contradicting that of [6], who argued that it is one of the most important attributes for game classification. Their claim was based on the observation that it is an outlier with low correlation to other game attributes, but we counter-argue that this does not necessarily imply its significance. They measured *savability* as a categorical variable whereas we measured it with a continuous scale, enabling us to use a more powerful method to analyse it.

The remaining 26 game attributes were used to evaluate the relations between the 16 clusters pair-wise. The number of significant differences for individual pairs was used to build a distance matrix. The process was applied for each of the three HC methods (Table 3). The distance matrices formed the database for multidimensional scaling (MDS), which is used to map MD data to a 2D representation. [22] applied the same method to analyse the similarities between games as directly perceived by their participants. However, such

holistic perceptions cannot provide the accurate game classification information which we aimed to identify through our attribute-based approach.

We generated a map from the distance matrix by using the R cmdscale function [5]. The three maps derived from the respective HC methods were superimposed for comparison. Each number on the map represents a cluster. For identification we assigned increasing numbers to the clusters, consistently across the three methods. Given the high similarities between maps, they were merged into one by using the mean values (Figure 3). This resulting map serves as the base for further analysis.

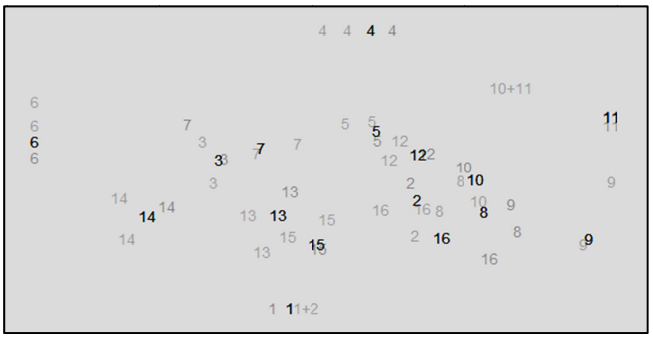

Figure 3: Mapping of the differences among the 16 game clusters with MDS; black numbers represent the mean over the respective values of the three methods (in grey)

Mapping to Seven Game Genres

To enhance the comprehensibility of the map, each of the 16 clusters was designated by a leading game with the highest frequency of being selected by the respondents (Figure 4) (NB: Cluster 10 and 11 have the same leading game as they were a single cluster as identified by the 1st HC method, Table 3). To validate the common seven game genres, we matched them with the mean value map (Figure 3). In the final question of the GCS, the respondent was asked to assign the game of interest to one (or more) of the seven genres. These data allowed us to calculate the percentage of the games in each of the 16 clusters that were assigned to a genre. The areas with the percentage above 70%, which was the lowest maximum percentage among the 16 clusters, were identified. Encircling the clusters with the percentages above the threshold leads to an initial **genre map** (Figure 4).

The seven genres distribute rather neatly over the map with only one cluster (**C**) unallocated (C3: "Angry Birds") and one cluster double assigned (C5: "Legend of Zelda"), forming the known combined genre ACTION-ADVENTURE. The genres of the other leading games match well with those they are originally classified in VGChartz 2012. This finding suggests that there is a general shared understanding of which game belongs to which genre. Besides, the clusters falling under the same genre are rather close to each other (except PUZZLE and ACTION), implying that they could work as an overall clustering solution.

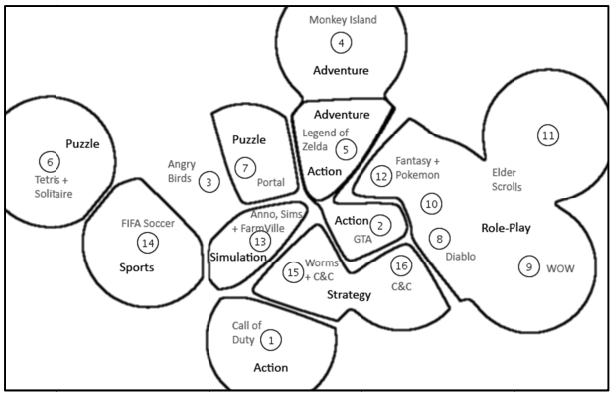

Figure 4: Genre map generated according to the percentages of the games in a cluster that were assigned to a known genre

To refine the genre definitions and to optimise the genre selection, the distribution of the game attributes over the genre map was also analysed with a mapping technique described as follows: To deepen the understanding how the clusters are related in terms of the game attributes, we visualized the relationships by greying the area of a cluster; the stronger an attribute is related to a cluster, the darker the grey colour is (Figure 5). A colouring threshold is determined, using different approaches for the two different types of variable.

Mapping of Game Attributes as Continuous Variables

As described earlier, all the continuous variables (except the two with numeric input) are rated with the range of 0-100. For a cluster, if 75% of the ratings for an attribute are above 25 (out of 100, thus also 25% deviation), then the cluster is coloured for that attribute. The allowed deviation 25% is to accommodate the systematic bias of the rating behaviour as some respondents tend to rate higher or lower in general [30]. The genre map (Figure 4) can be seen as divided into five major areas, which are identified by the cluster (C) number and the genre: C6-PUZZLE (on the left), C4-ADVENTURE (at the top), C1-ACTION (at the bottom), C9&C11-ROLE-PLAY (on the right), and the remaining in between (middle). This division could help refine game genres. We evaluated this idea by identifying the key game attributes of each area. In the following subsections we report the main findings.

Attributes of the ACTION-genre (C1, bottom)

C1 (genre/leading game: ACTION/"Call of Duty") comprises six attributes of different elements: *fight, opponents, time pressure, realistic world, competition* and *cooperation*.

The distribution of each of the attributes is depicted in Figure 5. Clearly, the attributes *fight* and *opponents* are not only highly relevant to the bottom area (ACTION) but also to the right one (ROLE-PLAY). However, *opponents* is irrelevant to C3 with the leading game "Angry Birds" where a player attacks other characters that do not fight back and by definition are not opponents. The attributes *time pressure* and *realistic world* are rather oriented towards the left (PUZZLE). A realistic representation of the game world is more relevant to the games in C14 (SPORTS/"FIFA Soccer"),

C2 (ACTION/"GTA"), and C1 (ACTION/"Call of Duty"). These together with C15 (STRATEGY/"Worms" + "C&C (Command & Conquer)") and C9 (ROLE-PLAY /"WOW") are strongly related to *time pressure*. The attributes *competition* and *cooperation* spread to the right.

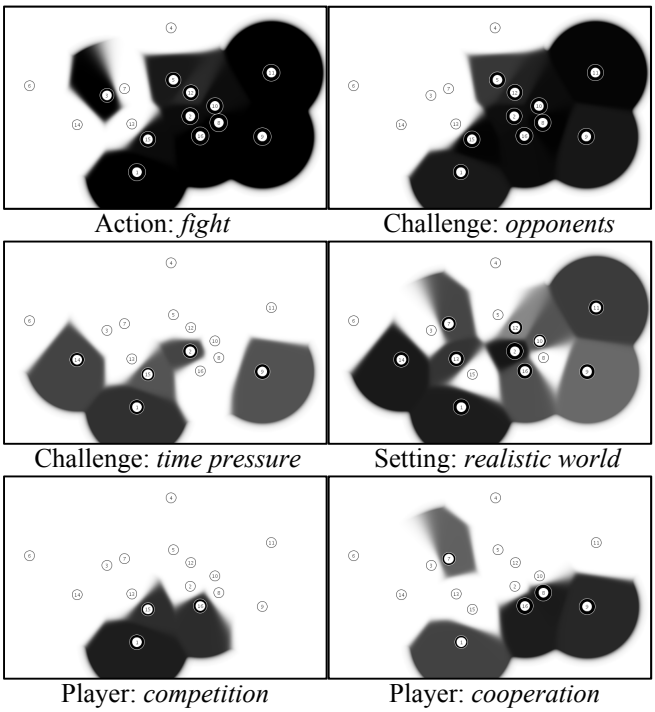

Figure 5: The distribution of the six game attributes of the ACTION-genre (bottom area) over the map (NB: the label is formatted as Element: *attribute*)

Attributes of the ADVENTURE-genre (C4, Top)

For C4 (ADVENTURE/"Monkey Island") eight attributes were identified: *collect, communicate, emotional connection to character, puzzle, search, fantasy world, explore,* and *story.* This top area and its right counterpart (ROLE-PLAY-genre) are closely connected. Apart from the obvious top area, the attributes *collect, explore, fantasy world,* and *story* distribute rather densely in the right and middle areas of the map. These and the attributes *emotion to character, puzzle,* and *search* cover C5 (ADVENTURE-ACTION/"Legend of Zelda"), which is located right below C4. Among them, *story* and *puzzle* are the only attributes that are related to C7 (PUZZLE/"Portal"), except for attributes not covering C4, like *obstacles*. The attribute *communicate* is located near C16 (STRATEGY/"C&C") and the two groups on the right.

The distribution patterns so identified are intuitive, because an ADVENTURE game typically involves exploring a fantasy world with a story and challenging the player with puzzles on the way of searching objects. The player might also develop emotional connection to the character(s) when undertaking the adventure.

RESOURCE Attributes (Eleven Groups, Middle)

Attributes primarily identified in the middle (eleven groups) but not in the other outer groups (except the groups on the right that comprise the majority of the attributes) are: *limited resources, produce, place,* and *obstacles*. Of particular interest is the attribute *collect*, which covers most of the middle and, together with *limited resources*, *produce* and *place*, defines C16 (STRATEGY/"C&C") and C13 (SIMULATION/"Anno", "The Sims" + "FarmVille"). The term 'RESOURCE' was chose as constituting the prevailing aspect of the area, e.g. collecting resources and producing as well as placing objects. It can well describe not only the more action-oriented game "C&C" where a military base is built and forces are provided with *limited resources* but also the non-violent game "FarmVille" where the resources are plants or animals grown in a farm.

Attributes of the ROLE-PLAY-genre (C9&C11, Right)

C9 (ROLE-PLAY/"WOW") and C11 (ROLE-PLAY/"Elder Scrolls") are mostly co-defined by the attributes of the bottom (Figure 5), top and middle area, making it an amalgam of ACTION, ADVENTURE, and RESOURCE games. In addition, the attributes *goal choice, personalize character,* and *player communication* are identified in this area. This lends further support to the observation that ROLE-PLAY games are inherently rich. These games normally provide players with a broad range of options including *goal choice* – the attribute shared with C2 (ACTION/"GTA"). The attribute *personalize character* of the element Actions can well epitomize ROLE-PLAY of which one of the focuses is configuring a character. *Communicating* with other players is an attribute shared with C16 (ACTION/"C&C").

Attributes of the PUZZLE-genre (C6, Left)

Incidentally, C6 (PUZZLE/"Tetris & Solitaire") is barely related to any of the 29 attributes measured as continuous variables, but strongly related to some of those evaluated categorically such as Player*: single player,* Perspective: *fixed*, and Goal: *static*. The attributes – *time pressure* and *realistic* – salient in the bottom area are related to this left area to some extent. So are *obstacles*, *fantasy*, and *fight* from the top area. Other attributes like *puzzle* contribute to the area, but are not distinctive (75% above 25 rating). Apart from these, the only salient attribute identified for C6 is *abstract world*, indicating that the games thereof are primarily based on a grid or a shaped background rather than a realistic or fantasy world.

Universal Attributes

Two attributes – *move* and *detail of graphics* - are related in (nearly) all the 16 clusters. As one defining characteristic of digital games is interactivity, the relevance of *move* to all the games is not surprising. Similarly, most digital games need some form of graphical representation (exceptions are purely text- or audio-based games), though to a different extent of detailedness. For instance, PUZZLE games such as "Tetris" are implemented as abstract worlds with less demand for graphical detail. In contrast, ROLE-PLAY and ACTION games typically require high graphical details.

Mapping of Game Attributes as Categorical Variables

As explained earlier, the categorical variables were not used for cluster analysis. This is not critical to the overall conclusion of our study as the continuous variables address the more important game elements. As the categorical variables can still provide relevant information to the design of educational games, we analysed the data using the same mapping technique as for the continuous variables but a different method to determine the colouring threshold. Specifically, for each group the percentage of the selected option for a categorical attribute was used to estimate the hue; the higher the percentage, the greyer the area is. For instance, for the element Goal**,** the attribute *goal type* has three possible values: static, various and self-defined. The respondents could select one (or more than one) of these options to define the game of interest.

The following elements comprise categorical variables: Player: *sociability*, Interaction: *I/O device*, Perspective: *view flexibility*, Goal: *goal type*, Rewards: *feedback format*; Structure: *continuity*, Setting/World: *dimensionality,* Action: *character*. Due to the space limit, we only give some results and do not provide the related attribute-distribution maps of which the basic ideas are illustrated in the previous section.

Goal Variability

Generally speaking, games with *static* goals are less complex than those with *various* goals. Results show that the distribution of both goal types over the map is consistent with this assumption with less complex PUZZLE games on the left (static goals) and more complex ROLE-PLAY games on the right (various goals); *self-defined* goals are less common.

Rewards/Penalties

Gaining rewards and avoiding penalties are typical game mechanics to sustain players' motivation (see Table 2b for the related questions). ADVENTURE games (the top area) tend *not to penalize* players but rather support them to progress steadily through a story. A simple but effective reward system is *high score*, which is often used in PUZZLE games in the left area. For ROLE-PLAY in the right area, rewards are more based on developing a game character through *power-ups*.

Structure

Most games are divided into *parts*, which may be linked through with a *storyline* or entirely self-containing. Most ROLE-PLAY games (C9&C11, "Elder Scrolls", right) and some SIMULATION games (e.g. C13, "The Sims", middle-left) offer open, explorative environments and support *continuous* progress. Some PUZZLE games (C6, "Tetris", left) are also continuous as they are too small to be split into parts. Games that most respondents claimed they could play through to the *end* are ADVENTURE games.

DISCUSSIONS AND IMPLICATIONS

We summarize the results by creating an overview **game genre map**, which depicts how the 29 continuous game attributes are related to the 16 clusters (Figure 6).

Research on Digital Educational Game Design

The arrows spanning across the map from left to right are three main routes to game enrichment. Here we define the richness of a game in terms of the number of attributes it implements (the darker the area the more attributes). The first route, which is close to the top area of ADVENTURE games, contains two enriching elements: the two attributes of the element Challenges – *puzzle* and *obstacles* – increase the demand of the cognitive ability or dexterity of players, and the attribute *story* can elaborate the structure of a game by expanding its possible courses. This route may be suitable for educational games that are rather cognitive demanding and of a slower pace. The second route, near the bottom area of ACTION games, also contains two enriching elements: *time pressure* of Challenges and *fight* of Action**.** Fighting can be quite complex with weapons and opponents. Educational games that are based on training, reaction or physical activity can fit this route. The third route is above the second and more concerned with the RESOURCE games (i.e., SIMULATION and STRATEGY). As an attribute of Challenges, resources imply collecting or managing objects which can be instantiated as educational content. All the three routes can lead to the richest game genre: ROLE-PLAY games, which, by combining the elements of the ADVENTURE, ACTION and RESOURCE genres, offer broad (i.e. the range of activities) as well as deep (i.e. the granularity of activities) game worlds for players to explore.

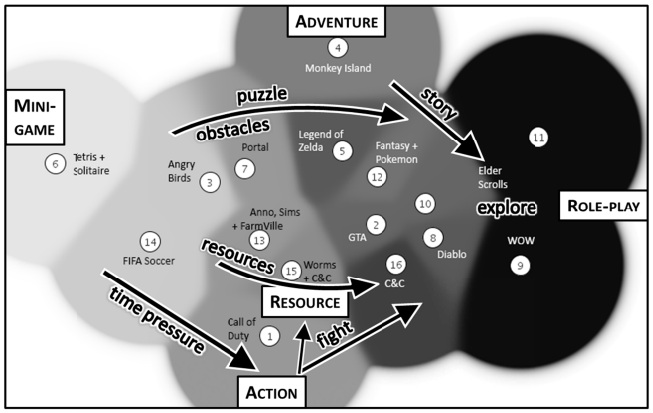

Figure 6: An overview of mapping all the continuous game attributes to the sixteen game clusters

When selecting a game genre for a DEG, the designer needs to consider a crucial question: "Which game attributes can be used for delivering specific learning content to specific target groups to attain specific learning outcomes?" Clearly, a host of pedagogical, technical, social and organizational issues come into play if we aim to find out not only *which* attributes to use but also *how* to use them or even *how effective* of using them. Addressing all these questions is beyond the scope of the current study whose results enable us to answer the critical 'which' question.

Using games as multifaceted as ROLE-PLAY for educational purposes increases not only the implementation effort but also the risk of losing focus on a learning topic. If the learning content is integrated in only one of the many

attributes of a rich game, the player may be exposed to less content within a short duration. This probably undermines the learning efficacy of the game. The implications drawn from these arguments are to adopt simpler games such as MINI-GAMES (cf. [13]) as a means for educational ends and to evaluate which attributes can be most suitable for the given educational content by considering the three routes depicted on the game genre map.

In fact, we have renamed the left cluster as MINI-GAMES instead of PUZZLE as most games in C6 are short, self-contained and built on a single principle [13], which is not necessarily to solve puzzle. [13], based on their analysis of 30 DEGs, argued that individual MINI-GAMES tend to be too shallow to attain learning goals and proposed building a compendium of MINI-GAMES as a DEG with each of them having different game mechanics. This proposal lends support to our idea of the three routes to game enrichment

Improving Game Genres

We have adapted three of the seven common genres (derived earlier from the different sets of game genres found in literature) redefined two and dissolved the other two into the other genre. The two discarded genres are SPORTS and SIMULATION. Both describe the content of a game rather than its game mechanics. SPORTS can be re-categorized as ACTION games with sports content. In the game map, they are located close to the ACTION area. Similarly, SIMULATION describes only one aspect of the game: it simulates a situation or a topic. On the map, it is located in the RESOURCE area. This suits many SIMULATION games that are based on real-life processes such as simulating a person's life (e.g. "The Sims") with resources such as food, furniture and other objects or simulating a farm with growing plants (e.g. "FarmVille"). Other SIMULATION games like driving or flight match better with ACTION games. Nonetheless, given the highly diverse and thus non-discriminative nature of this genre, SIMULATION seems not particularly useful and should be discarded. The genre PUZZLE has been renamed based on the reason already mentioned, but may function as a substitute for MINI-GAMES, as it is still a more commonly known term. The same applies for the STRATEGY genre, which has been renamed RESOURCE, based on the defining attribute in this area.

CONCLUSION AND FUTURE WORK

In summary, our results enable us to conclude with five game genres - MINI-GAMES, ACTION, ADVENTURE, ROLE-PLAY and RESOURCE and their defining attributes (Table 4). In the game genre map derived from the survey data (Figure 6), the clusters with largest distances (top, bottom, left and right) have the more distinct sets of attributes, and another set was identified in the middle. Mixtures of genre are possible if a game is located between two genres on the game genre map. Its attributes should then be a mixture of two (or possibly more) neighbouring genres. If it was possible to clearly separate game genres, these genres should have emerged as clusters. The results however indicate that there is always an overlap between game genres, which probably matches the experience of game designers and researchers. The advantage of the game genre map is that this overlap is clearly visible and kept to a minimum by choosing the points furthest apart as the centres of the new genres. By locating a game along the four cardinal directions of the map, its complexity and game type can be derived. By identifying its defining attributes, the game nature can be better understood.

As stated above, this study is an integral part of a project that aims to compare the efficacy of different game types for delivering specific learning content. Based on the results we analysed existing DEGs for learning programming to find out what game genres are preferred for this topic and how the attributes of the genre support the learning. We planned to design digital games to teach a key programming concept 2D array, using the game genre map to support our design decisions. In one study we aim to compare games which are located close to each other on the game genre map and differ in a single attribute to study the impact of this attribute. In another study we aim to compare games which are further

Element	MINI-GAME	ACTION	ADVENTURE	ROLE-PLAY	RESOURCE
Player	single player	(multi player), (competition), (cooperation)	single player	(multi player), (cooperation), (communication)	(multi player), (competition), (cooperation), (communication)
I/O	(mobile device)		(PC)	(PC)	PC
Actions	move: (restricted), (fight), (character: none)	fight, move: free, character	collect, move: (free), (communicate), char: emotion	fight, move: free, collect, communicate, (produce), char: emotion + personalise	(produce), collect, (place), move: free, (communicate), (fight), (character: none)
Challenges	(obstacles), (time pressure)	opponents, time pressure	puzzle, search	opponents, (search), limited resources, (obstacles)	limited resources, (opponents),(time pressure)
Goals	static	static, (various)	(static), (various)	choice, various, (self-defined)	(static), (various), (self-defined)
Rewards	score	(score)	(no penalties)	power-ups	(score)
Setting	abstract, (realistic), (fantasy), 2D, (3D), pre-defined	realistic, graphical detail, 3D, (selectable)	explore, fantasy, (2D), (3D), pre-defined	explore, fantasy, realistic, graphical detail, 3D, (selectable)	(explore), (fantasy), (realistic), (2D), (3D), (selectable)
Perspective	fixed	(bound to char)	(fixed), (bound to char)	bound to character	freely moveable
Structure	(game is finished), (divided into parts), (continuous)	(game is finished), (divided into parts), (continuous)	story, game is finished, divided into parts	story, continuous, (endless)	(game is finished), (endless), (divided into parts), (continuous)

Table 4: The five recommended genres and their defining attributes with those in brackets being less distinct for the genre.

apart to identify how large the impact of game genre choice may be on the learning outcome and player experience. Results of the planned studies will enable us to substantiate the value of our game genre map.

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