# The Influence of Game Features on Collaborative Gaming: A Process-oriented approach

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## Abstract:

*Game technology and design are creating powerful collaborative gaming experiences that can be exploited pedagogically. Building on a research trends from various fields, a process-oriented model is adopted to evaluate the instructional potential of games, considering both their surface and deep structure. Two experimental approaches are adopted. Through reflective evaluation the Neurocognitive skills employed, 'Perceived Competence Facilitation' and 'Perceived usefulness' of games are determined. Video recordings of experimental sessions were analysed to quantify the gaming experience by capturing the type, frequency and directionality of interactions triggered by different games. The interaction between different game features and various dependent variables were analysed statistically and the results discussed from a pedagogical perspective.*

## 1. Introduction

The quantum leaps in processing power and connectivity of gaming technologies, together with innovative perspectives in game design, are transforming solitary and collaborative gaming into a highly elaborated, immersive, social experience that proposes unlimited pedagogical benefits if exploited appropriately. There is a pressing need for pedagogical models that challenge the prevalent product-oriented evaluation of games focusing solely on surface features such as interface design, navigational tools, game characters and environment. Comprehensive models that integrate reflection on games as 'objects', with complementary evaluation of the gaming experience, should be employed to analyse the complex scenarios characterising both solitary and collaborative gaming. A process-oriented evaluation of the deeper structure of games [1] targets user entry perceptions of game features, Task and Person-oriented interactions (T&POIs) triggered by a game, together with the socio-emotional atmosphere that evolves during collaborative gaming.

Due to major limitations, both in scope and underlying epistemology (considering learning mainly as an acquisition process), existing models for evaluating IT tools and software cannot be applied for assessing solitary or collaborative gaming. Inspired by a Constructionist epistemology [2], [3], Self-Determination theory for motivation [4], [5] and Cognitive

Neuroscience [6], [7] regarding cognitive and affective processes, a process-oriented model is proposed as a framework for evaluating group-based gaming. T&POIs triggered by different genres of games and game features are categorised along the domain, technology and community dimensions. These T&POIs are also classified across three pedagogical levels to capture the personal and social needs of novice, experienced and expert players participating in collaborative gaming. The model also includes an interactions management meta-level for controlling gaming along the identified dimensions through reflection. A more detailed discussion of this model as applied to technology-intensive collaborative learning environments (TICLEs) can be found in [8]. Individual and social metacognition in TICLEs is discussed in detail from a Constructionist perspective in [9]. The gaming experience is thus evaluated at two levels: gamer/s interaction with the surface features of games, and the deeper dimension considering interactions at the perceptual, experiential and metacognitive levels.

# 2. Methodology

Two experimental approaches were adopted to investigate perceptual and experiential aspects of collaborative gaming. Surveys were used to explore how game features determine game appeal by considering gender-related neurocognitive propensities, perceived usefulness, perceived competence facilitation and perceived need satisfaction along the domain, gaming and social dimensions. The other approach involved capturing collaborative gaming sessions on video to determine the influence of game design features, mainly the degree of autonomy and interactiveness (sharability), on the frequency and directionality of T&POIs. Autonomy is defined here from the perspective of Self-determination theory as the 'sense of volition or willingness when doing a task'. When activities are done for interest or personal value, perceived autonomy is high. Game features that promote this include provision of choice, use of rewards as informational feedback and non-controlling instructions, [10]. The underlying hypothesis asserts that games with more appealing features, that increasingly give more autonomy to users and that are more 'shareable', enhance group activity manifested as higher frequencies of T&POIs interactions. Consequently, the main research question is: 'How can games be evaluated through a process-oriented approach that combines user perceptual analysis with interactivity at the task and socio-emotional levels? This major research question was operationalised through a number of empirical research questions (ERQs) each focusing on factors that influence personal appeal and interactions triggered by a particular game. These investigations were carried with a sample of 16-18 year old college students in controlled experimental sessions using six games: Alpha Centauri (AC), Empire Earth (EE), Age of Empires (AoE), Mind Maze (MM), the SIMS and Need for Speed (NfS). These were selected because their deep structure stimulates qualitatively and quantitatively different interactive experiences. Surveys were administered to collect data about participants' gaming profiles and perceptions. Experimental groups were set up to interact with different games during controlled sessions recorded on video. Video recordings were then analysed to quantify the type, frequency and direction of interactions. Scores from surveys and frequencies of different categories of interactions were entered in SPSS and analysed using appropriate statistical tools. A summary of results and related discussion of the constructs under investigation is given below according to identified empirical research questions:

# 3. Statistical Analysis and Results

ERQ 1: *Does game genre influence game choice and use*?
A survey carried out with a sample of 367 students (241 females, 65.7%; 126 males, 34.3 % ) showed distinct choice tendencies between male and female students, [11]. Females opted for puzzle, fighting and managerial games, while males preferred first person shooters, role playing, sport and strategy games. These tendencies manifest accommodation to underlying gender-related neurocognitive processes. Females prefer games that exploit their natural propensities involving perceptual speed, fine motor skills, sequenced hand movements and tasks which require rapid access and retrieval of information from memory. Males prefer games that demand higher visuospatial abilities, mainly localisation, orientation, mental rotation, target-directed motor skills, greater reaction speed, increased aggression, greater risk taking and tasks require maintenance and manipulation of information in working memory. Males prefer a command structure that makes them 'feel in control' as they are not afraid of taking risks. Females favour a more concrete, contextualised, intimate 'bricolage' approach, preferring not to take risks while learning or gaming. The appeal of game genre to males and females depends on the intuitive evaluation of the type of neurocognitive skills that are demanded by the game both at the individual and collective levels as discussed in detail in [12].

ERQ 2: *Is perceived competence facilitation related to game genre?*
A survey was carried with 86 students who regularly played any of the following five games: EE, AoE, Civilisation, NfS and the SIMS. This survey included 27 statements, scored on a five point Likert scale, assessing nine perceived competences comprising acquisition, sharing and mediation along the domain, gaming and community dimensions. Besides 27 ordinal variables derived from the survey statements, three other computed variables were created to give the mean of perceived competence in each of the three dimensions (Computed Domain, Gaming and Community Competences). Using one-way ANOVA the means of these variables were analysed in relation to the games used. Statistical significance shows that games are perceived to promote different competences. EE, AoE and Civ were perceived to promote competences related to the history domain. NfS was perceived positively at promoting gaming skills, while AoE was perceived effective at developing community management competences. SIMS was perceived least effective at developing any of the competences.

ERQ 3: *Is game appeal related to perceived usefulness of game?*
A survey about perceived usefulness of game features was developed including statements about accurate representation of and insight into domain knowledge, use of tutorials, navigation tools (time-line or maps) and reference tools such as encyclopedias and glossaries. Another set of statements explored the perceived usefulness of features that could be integrated if a new version of the game was developed, assuming that users would prefer to extend and elaborate existing appealing games. One-way ANOVA of means for these ordinal variables with game type gave statistically significant results. History games showed statistical significance for degree of vividness and reality experienced in the game environment. No statistical significance was obtained for perceived usefulness of tutorials, time-lines and reference tools. Chi square analysis of game type with features perceived as useful in a newly designed game gave statistical significance for the following game features: game made available on mobile gaming device, integrated WiFi and LAN connection, connection to ambient interactive systems, inclusion of instant messaging tool bar, design tools for creating 'Mods' and option to change to 'Simulation'

mode. With these features EE, AoE & SIMS were perceived more attractive, making gaming and learning more interesting and giving user more control. But Civ and NfS were perceived less useful with these features.

ERQ 4: *Does game genre influence social interactions and appeal?*
Game genres vary in their potential to promote social interaction that leads to bond formation and a sense of relatedness. T&POIs generated by a game embody a characteristic socio-emotional climate. Appealing games promote friendly expressions and generate positive POIs such as pleased looks, approving gestures, jubilant exclamations and positive comments to recommend the game. Less engaging games promote more negative socio-emotional climates characterised by neutral looks, disapproving gestures, disengagement, negative comments censuring the game and a non-friendly attitude manifested through solitary non-interacting, possibly detached comportment. GLM Multivariate statistical analysis of game type with frequencies of POIs and expressed friendship revealed that games like NfS, SIMS, AoE and MM promote interaction and interpersonal communication that give an enhanced sense of relatedness. Controlled, repetitive gameplay, uninteresting storyline, limited options and poorly designed game environments characterising games like AC and EE create a socio-emotional climate that suppresses interactivity and interpersonal communication. The expressions of friendship shown by participants in experimental settings using different games confirm this trend. The solitary friendship condition, where participants interact with the game but not with each other, was evident in EE, AC, MM. A more friendly and interactive climate evolves in games like AoE and NfS.

ERQ 5: *What is the influence of user control provided by a game on interactions during collaborative gaming?*
Experimental sessions were organised to explore the influence on collaborative gaming of six games that vary in user control and gameplay. The frequency of T&POIs, individual gaming role and directionality of interactions were recorded. Directionality refers to ‘one-to-one’ or ‘one-to-all’ interactions. GLM analysis showed that games like AoE, MM and SIMS, which give user more control and autonomy developed higher levels of TOIs. AC, EE and NfS, which are more restrictive on user autonomy, showed much less intense interaction profiles, a trend confirmed through analysis of single TOIs and individual gaming roles. ‘Leader’ and ‘Guide’ roles that show enhanced willingness to interact with the game and participants were more frequent in AoE, MM, SIMS and NfS, while less common in restrictive games like AC and EE.

ERQ 6: *What is the influence of game sharability on interactions during collaborative gaming?*

Different genres of games promote different type of tasks and hence interaction patterns. Some tasks are less “shareable” than others. Playing a puzzle game, a racing or a first-person-shooter can hardly be done collaboratively because these involve reflex gaming gestalts and perceptual processes that are not easy to verbalise (if they are open to introspection at all on grounds of their intuitive nature). In contrast, some tasks are inherently distributed, either geographically (e.g., multi-user on-line games), functionally (e.g., playing the role of a member from different factions in a multi-user strategy game) or temporally (e.g., changing roles along a gaming session). Thus the nature of interaction is such that it can have a wide range of values. Puzzle

games are less sharable or have a lower level of interactiveness, while managerial or strategy games are on the higher end of the spectrum. Therefore, sharability or interactiveness is an index of "gaminess". The games with low level of interactiveness provide very limited modes of interaction (binary decisions, e.g. to stand or to run) and do not allow players to invest themselves much into the play, or to react in more elaborate and intensive ways to their opponents. The games that provide richer interaction allow players to interplay with each other at various levels showing higher frequencies and repertoires of interactions directed to different members of the group. Such games are more interesting and appealing. Moreover, a set of rich interaction modes has not only psychomotor, but most important emotional significance. Sharability promotes in game and group-based autonomy, creates intense positive socio-emotional environments and promotes social interaction that satisfies the need for relatedness.

Thus the level of interactions observed in collaborative gaming contexts can serve as an indicator of the degree of 'sharability' of a game. It is hypothesised that a more sharable game will be characterised by higher levels and variety of interactions, more positive socio-emotional climates and a higher degree of interpersonal interactions. GLM analysis for separate TOIs gave statistically significant interaction with AoE, MM, SIMS and NfS, implying a more shareable nature than AC and EE. GLM analysis of total communication activity (a covariate created by computing all separate TOIs), gave a statistically highly significant ($p< 0.008$) interaction with the type of games used. This confirms previous analysis that AoE, MM and SIMS generate more communication activity implying a more sharable nature. Assuming that a more shareable game encourages 'one-to-one' and 'one-to-all' interactions, GLM analysis was performed separately on each of these covariates and also on a third variable developed by computing them. The three covariates gave a statistically highly significant ($p< 0.000$) interaction with game type. NfS, SIMS and GE stimulate more 'one-to-one' interactions than AC, EE and MM. AoE, NfS and MM stimulate more 'One-to-all' interactions. Also, game sharability was rated according to the mean number of interactions. The following rank order was obtained starting from the most shareable with the highest mean: NfS (84.39) > AoE (76.5) > SIMS (62.98) > MM (54.451) > AC (49.39) > EE (42.07). Game shareability can be quantified through the type and directionality of interactions observed during collaborative gaming.

# 4. Conclusion

Evaluating the role of games in collaborative gaming is a complex task involving analysis of individual, group and game features. Individual characteristics affecting interactions in collaborative gaming are discussed in [13] while group features are discussed in [14]. The surface and deep structure of games have to be analysed to identify features that affect personal appeal and influence interactions along the domain, technology and community dimensions. Decisions about the use of games for learning should be informed by reference to intraindividual and group-based experiential processes. Through intraindividual intuitive, perceptual, cognitive and affective evaluative processes (discussed in more detail in [15], the level of game appeal is establish considering the game's potential in accommodating gender-related neurocognitive propensities, the degree of autonomy delegated to user and perceived usefulness in addressing needs for competence, relatedness and self-actualisation. At the experiential level, the suitability of games for collaborative contexts should be evaluated taking into consideration group processes. Such processes involve the degree of interactiveness mediated by a game involving

interpersonal communication both at task level (suggesting, giving assistance, providing feedback) and complementary expressions of feelings (encouragement, censoring, complimenting) that contribute to the development of a characteristic socio-emotional climate generated by a game. The empirical validation of these criteria involves the quantification of T&POIs, directionality of interactions, manifested individual expressions of friendship and roles adopted by participants while gaming.

This investigation shows the importance of game features in the complex collaborative gaming scenario and thus their key role in a game-centred pedagogy. In the context of the proposed process-oriented pedagogical model, game analysis is considered from the perspective of neurocognitive skills demanded by the gaming task. While accommodating for gender-related neurocognitive and affective propensities, any shortcomings in behavioural tendencies are challenged by proposing complementary measures. In other words, while appreciating that males are more attracted to games demanding visuo-spatial and navigational abilities, and that they are more inclined to adopt command strategies and coalition based gaming, at the same time they should be made aware of their avoidance or lack in affinity to games with a linguistic component, or those employing rehearsal strategies and more collegial approaches. Females should be made aware of the need to train their visuo-spatial skills and use more assertive strategies.

As with other learning technologies, front end analysis of the game to be used in learning contexts should promote reflection to address perceptions about the competences that the tool is capable of developing. Prior to the use of a game for learning, its resourcefulness for developing competences in acquiring domain knowledge and skills, for developing sharing competences in collaborative contexts and its potential for developing mediational competences has to be established through direct use by learning designer or through evaluation from more competent players. The tools that develop these competences should be identified and discussed especially with novice gamers to address their initial perceptions and possible apprehensions. In traditional, teacher-driven didactical contexts, perceived usefulness of games for learning is very limited. Learners need to be sensitized about the potential of games for developing insights into domain models, their promotion of problem-solving skills, training in self-directed and inquiry-based learning, long term effects on process intelligence, learning-in-action by developing competence through performance (the ‘performance before competence’ principle, [16] and developing domain expertise through enacting the role of experts [17].

The direct link between game type and the socio-emotional climate developed during gaming should be appreciated. Group involvement and the level of satisfaction developed by a game can be assessed from the type of body language, facial expressions, the level of communication activity and from the type, frequency and directionality of interactions. Good games sustain group interactions while games that lack in design create dissent and disengagement of participants. Before using games for pedagogical purposes analysis should be done for the type of game play offered by identified game. Game design is controlled in relation to functionalities of game characters and degree of realism of the game environment. Other important features include the level of control delegated to user, game play modes, the nature of the storyline, the options offered by the game for understanding and elaborating the story line.

Two other important features to be considered when choosing games for learning is the level of control the game provides users and the degree of sharability it offers. Games delegating control to users are much more motivating [18] and thus facilitate more the merging of learning with gaming. In collaborative contexts, the degree of sharability of a game will directly impact the level of interactions and hence learners' participation and contribution to the game-centred learning process.

Thus the proposed process-oriented model moves beyond subject content criteria and advocates a dynamic method for evaluating gaming scenarios. Capturing interactions along the domain, technology and community dimensions and across novice, competent and expert pedagogical levels give a more comprehensive description and a better analysis tool for pedagogical application. The integration of the experiential level with a complementary metacognitive component merges game engagement with reflection on learning. Thus the proposed process-oriented model addresses in a very practical way the plead by various game researchers [19]; [20], [21]; [22]; [23], [24]; [25] for embedding the gaming experience within a pedagogical framework. Though the instruments used need further refinement and validation with bigger representative samples, this investigation demonstrates that an interactions-oriented approach is a more valid and comprehensive methodology to be used in technology intensive collaborative environments and to inform pedagogical decisions. Future research should focus on applying this model to different age groups, to a wider range of games from different genres and to competitive context besides collaborative ones.

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