

Towards a Serious Game Experience Model: Validation, Extension and Adaptation of the GEQ for Use in an Educational Context

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Abstract

In this paper, we present the results of game experience measurements of three design stages of the serious game Poverty Is Not a Game (PING) using the FUGA Game Experience Questionnaire (GEQ) extended with a Perceived Learning (PL) module. It is hypothesized that subsequent design stages will evoke a more positive game experience and higher PL. In a first step the factor structure and convergent and discriminant validity of the existing GEQ modules are tested yielding disappointing results. Next an adapted version is proposed yielding more acceptable results. Based on this model, the different design stages are compared failing to yield significant differences either for most GEQ dimensions (except for challenge and competence which is probably related to usability issues) or for PL. Significant differences were found between classrooms however pointing to the importance of taking into account context in future research. Moreover, game experienced proved to have an effect on the experience of learning.

Introduction: Serious Game Experience

Although game experience has become an important concept in recent academic research concerning video games (see e.g. IJsselsteijn, de Kort, Poels, Jurgelionis, Bellotti, 2007), attempts to clearly define it are scarce. This can probably be attributed to the complex, subjective and dynamic nature of the idea of experience (Buchenau & Suri, 2000). Ermi & Mäyrä (2005) describe game experience as ‘an ensemble made up of the player’s sensations, thoughts, feelings, actions and meaning-making in a gameplay setting.’ This definition gives us a notion of the concept by implying a relationship between game, gamer and context. However, it also uncovers its problematic nature by referring to a variety of agent-dependent, hence subjective processes making clear that ‘The experience of play comes in so many forms that creating a single catalogue that takes all of them into account would be an impossible task’ (Salen & Zimmerman, 2004, p.314).

It could therefore be more interesting to approach game experience from a different angle than an ontological one. By reframing the question as why the concept of game experience has become a topic of interest for academic research, it can be narrowed down to a workable proportion. As such, game experience is directly related to the motivational aspect of gaming which is in turn connected to the question of what makes video games enjoyable (see e.g. Vorderer, Hartmann & Klimmt, 2003; Sweetser & Wyeth, 2005; Shen, Wan & Ritterfeld, 2009). In that respect, game experience can be considered as the underlying mechanism that makes video games intrinsically motivating and fun.

A central concept in relation to enjoyable experiences is that of flow or optimal experience which can be described as ‘an optimal, intrinsically motivating experience induced by an activity in which one is fully absorbed’ (Csíkszentmihályi, 1990). Although Sweetser & Wyeth (2005) adapted this construct into a game-specific model with eight correlating dimensions (concentration, challenge, skills, control, clear goals, feedback, immersion and social interaction), attempts to thoroughly operationalise the multifaceted

construct of game experience are scarce as most attempts are limited to using either one dimension of the game experience or employing a narrowed-down version of the flow concept (see e.g. Douglas & Hargadon, 2000; McMahan, 2003).

From 2006 to 2009, however the “Fun of Gaming” (FUGA) project funded by the European Community has worked towards measuring the human experience of media enjoyment (see IJsselsteijn, van der Hoogen, Klimmt, de Kort, Lindley, Mathiak, Poels, Ravaja, Turpeinen & Vorderer, 2008). One of its core tasks was to develop a Game Experience Questionnaire (GEQ) to measure the game experience. This self-report measure consists of three modules: a core module, a social presence module and a post game module and has been used in several studies. For instance, Gajadhar, de Kort & IJsselsteijn (2008) used the GEQ to determine the effect of social context on video game enjoyment and found social presence to be a mediating factor. Nacke, Stellmach, Sasse & Lindley (2009) on their turn used the core module of the GEQ to assess the game experience in a gaze interaction game while Nacke & Lindley (2008) used the core module in combination with psychophysiological measures and video recording to explore flow and immersion in a First Person Shooter. Except for the initial construction of the GEQ however, no information is available regarding the validity of the GEQ. Moreover, as far as we know, no attempt has been made as yet to validate the application of the GEQ to the domain of serious or educational games. Considering these issues, this leads us to formulate our research question.

RQ1: Do empirical data confirm the construct validity of the GEQ?

In this paper we report on the testing of the alpha, beta and release candidate versions of the game PING. Since the GEQ was primarily constructed to be used for measuring the experience of commercial games, its use in a formal learning environment requires the adoption of another experiential dimension, c.q. the experience of learning itself, which has in previous research been conceptualized as a flow effect (Kiili, 2005). The only attempt we know of to link perceived learning with game experience is that by Fu, Su and Yu (2009) which consisted of a scale based on Sweetser & Wyeth’s Gameflow Model (2005) adapted to the

specificity of what they call e-learning games. However, as this measure is only applicable to video games with clearly defined learning outcomes, it was decided that it was unfit to be used for a video game under development of which the primary aim was to raise consciousness about poverty. It was therefore decided to build a perceived learning scale that takes into account the taxonomy used by Rovai, Wighting, Baker and Grooms (2009) (including affective and cognitive learning) and the first two levels proposed by Kirkpatrick (1998) to evaluate training courses, namely Reaction (level 1) which pertains to the affect of the respondent towards the learning method and Learning (level 2) which corresponds with the affective and cognitive learning dimensions used by Rovai et al. (2009).

As enjoyment in games is strongly intertwined with aspects of usability (see e.g. Federoff, 2002), it is not unreasonable to assume that improvements in the design of a video game will have their effect on the game experience.

H1: The game experience will become significantly more positive over the three design stages of PING.

Furthermore, it can be expected that the game experience and the experience of learning are positively correlated (Kiili, 2005).

H2: There is a positive effect of the game experience on perceived learning.

Since we expect the game experience to become more positive over the different design stages of the game, as a consequence, perceived learning will likewise be affected.

H3: Perceived learning will rise significantly over the three design stages of PING.

The Game

PING (Poverty Is Not A Game) was commissioned by the King Baudouin Foundation and is an initiative as part of the European Year for Combating Poverty and Social Exclusion (2010). Its primary aim is to raise consciousness in adolescents concerning poverty and social exclusion in a way that is close to their everyday lives. The game takes place in a three-dimensional environment which represents an average Western European city. Players can choose between a male or female avatar. Although the decision to play with a certain avatar has an impact on the storyline, the central message the game wishes to convey stays the same. It hopes to raise consciousness concerning the mechanisms underlying poverty and is specifically aimed at what is sometimes referred to as the fourth world.

No detailed accounts exist concerning what has changed between the different design stages of PING (Alpha, Beta and Release Candidate). An informal conversation with the game developers revealed that changes primarily pertained to the story of the game and to the navigation in the game. The Alpha stage only consisted of a rudimentary storyline while orientation in the 3D game world was a challenge as no maps were readily available. In comparison, the Release Candidate (RC) provided a fully developed story which could be finished in about 50 minutes. Navigation was facilitated by a mini-map with GPS functionality. Similar in all design stages is the fact that PING had no sounds or music.

Method and Procedure

Data Collection

Data were collected by testing PING in a total of 22 classrooms. To measure game experience, an online survey consisting of several blocks was used. A first block was the core module of the GEQ and inquired how the player felt whilst

playing the game (92 five-point Likert scale (FPLS) items: Not at all, Slightly, Moderately, Fairly and Extremely). A second block was the social presence module and consisted of 25 FPLS items. Then a first part of the perceived learning scale followed (10 FPLS items). Next are the post-game module (21 FPLS scale items) and the second part of the perceived learning scale (10 FPLS items). A subsequent block of the survey explores the gaming behavior of the respondent. The three final questions asked about sociodemographic characteristics (gender, age and education level). In total, the survey was filled out by 373 respondents of which 340 were retained after data cleaning.

Population and Sampling

As PING has been specifically developed for use in a classroom, the obvious consequence is that it needed to be tested in the classroom as well. For the sake of uniformity it was tested in third and fourth grade classes only (age: 14-16 years). Furthermore, participation was limited to General and Technical educational levels. Our population thus consists of all third and fourth grade students attending a General or Technical class in a school certified by the Flemish Government.

Sampling was performed on the basis of a database of schools listed on the website of the Flemish Ministry of Education (<http://onderwijs.vlaanderen.be/>) and on the basis of a database of schools provided by the King Baudouin Foundation. Schools were picked out at random and were sent an e-mail asking for their cooperation. Schools that did not respond were contacted by telephone.

Procedure

The general procedure was the same for all test phases and for all classes. The teacher in charge of the class was asked to give a brief introduction about the video game and about the subject matter (poverty). After this introduction, students could start playing. Due to the status of the game, during the Alpha phase, students were allowed to play for approximately 25 minutes while students

were allowed to play for 50 minutes during the Beta and Release Candidate phases. After playing, students were asked to fill out an online survey.

Scale Validation

We first assessed the construct validity of the GEQ to evaluate its appropriateness in the context of a pre-launch serious game in a formal learning environment. Construct validity was accounted for by testing the factor structure of the core module, the social presence module and the post game module and by using measures accounting for convergent and discriminant validity. To test the factor structure we made use of confirmatory factor analysis which 'is a way of testing how well measured variables represent a smaller number of constructs' (Hair, Black, Babin, Anderson and Tatham, 2006). As proposed by Hair et al. (2006) we checked convergent validity by means of the coefficient alpha and the average percentage of variance extracted (VE). Discriminant validity was examined by comparing the VE of two constructs with the squared correlation of those two constructs. The rationale behind this is that a latent construct should explain the variance in its items better than that it explains another construct. To complement the GEQ a perceived learning scale was constructed and tested for its construct validity.

Results

Construction of a Serious Game Experience Model - Core Module

Goodness-of-fit indices (N=330, $\chi^2/df = 2.86$, CFI = .78, TLI = .75, RMSEA = .075, CI90 = .071, .080) were not satisfactory as CFI and TLI scores suggest that the proposed model did not fit our data. This is confirmed when checking for convergent and discriminant validity as none of the core module's dimensions has an acceptable VE. This 'indicates that on average, more error remains in the items than variance explained by the latent factor structure imposed on the measure' (Hair et al., 2006) which points to a problematic scale. When checking for

discriminant validity, six concepts show considerable similarity with other concepts, i.e. Competence, Immersion, Flow, Positive Affect, Challenge and Annoyance. More specifically Competence, Immersion and Flow explain each other better than they explain the variation in their own items. The same is true for Annoyance and Challenge and for Positive Affect and Competence. Only the concept Negative Affect proves to be different enough.

GEQ Social Presence Module

Goodness-of-fit indices of the social presence module were similar to that of the core module (N=330, $\chi^2/df = 3.68$, CFI = .84, TLI = .81, RMSEA = .090, CI90 = .081, .099), which indicates that the data do not fit the proposed model. Moreover none of the dimensions has an acceptable VE statistic while coefficient alphas seem to suggest reliable scales. Discriminant validity was not satisfactory for Empathy and Behavioral Involvement and for Negative Affect and Behavioral Involvement.

GEQ Post Game Module

Goodness-of-fit statistics show that our data do not fit the proposed model (N=330, $\chi^2/df = 4.44$, CFI = .84, TLI = .81, RMSEA = .102, CI90 = .093, .111). Concerning convergent validity, all dimensions yielded an acceptable coefficient α but only Tiredness explained sufficient variance. Discriminant analysis for the post game module showed that three of the four dimensions are not different enough. It concerns Negative Experience which relates to Tiredness and Returning to Reality.

Construction of a Perceived Learning Scale

Of the total item pool (20 items), nine items were retained to construct the perceived learning scale. Two items composed the construct of Affective Gaming which assesses how one responds to receiving education through video games while the construct of Learning (7 items) explores to what extent the respondent thinks they have learned something on the topic of poverty. This model was inputted in AMOS and resulted in a good fit ($N=330$, $\chi^2/df = 1.79$, $CFI = .99$, $TLI = .98$, $RMSEA = .049$, $CI90 = .025, .071$) while both Convergent and Discriminant validity proved to be acceptable.

Towards a Serious Game Experience Model

As the current structure of the GEQ was considered as inadequate for our further exploration (RQ1), it was decided to build our own serious game experience model in which the item pool and dimensions of the GEQ served as a starting point. Furthermore, we aimed to incorporate our own perceived learning scale.

The first decision we made was to leave out the social presence module since this module was not deemed fit to assess the complex and rich nature of social interactions that emerge during gameplay in a formal learning environment. Moreover, the construct of Tiredness of the post game module was omitted as it proved to be highly context-dependent (being tired was not due to gaming but to the moment of testing).

All three modules were reviewed and adapted based on item distributions, coefficient alphas, corrected item-total correlations and the one-dimensionality of the dimensions. This eventually resulted in a model in which game experience and post game experience were conceptualized as second order constructs. Game experience is composed of eight first order constructs: Competence (2 items), Vividness (3 items), Negative Affect (2 items), Positive Affect (3 items), Immersion (2 items), Challenge (2 items), Affective Gaming (2 items) and Learning (7 items). Post game experience consists of Positive Experience (3 items), Negative Experience (3 items) and Returning to Reality (2 items). Annoyance was omitted since this construct proved to be impossible to build from the applicable data. Furthermore, the construct of Challenge did not result in an

acceptable scale either but was retained on the basis of theoretical and practical considerations.

Fit indices of the proposed Serious Game Experience model yielded an acceptable fit ($N=330$, $\chi^2/df = 1.84$, $CFI = .93$, $TLI = .92$, $RMSEA = .050$, $CI90 = .045$, $.056$) This model (see Figure 1) served as the foundation for our further exploration of the serious game experience of PING during its subsequent design stages. It shows that Vividness (.94), Positive Affect (.93), and Immersion (.76) are strong predictors for Game Experience while Competence (.37) and Affective Gaming (.42) are moderate predictors. The fact that Learning has a standardized regression weight of .50 confirms our hypothesis that there is a positive effect of the game experience on perceived learning (H2). Remarkable is the fact that Game Experience has no effect whatsoever on Challenge (.01). As for Post Game Experience, Returning to Reality (.97), Positive Effect (.65) and Negative Effect (.74) are strong predictors. Finally, by connecting the error terms of Affective Gaming and Learning, of Competence and Challenge and of Negative Affect and Positive Affect, we wanted to examine if those constructs shared variance that was not explained by the Game Experience construct. The rationale behind this was that it could be expected, on theoretical grounds, that those constructs share other common causes for their variation. This was confirmed for Competence and Challenge (-.57), Affective Gaming and Learning (.36) and for Positive Affect and Negative Affect (-.63).

The Evolution of Game Experience - During Subsequent Design Stages

To compare how the different dimensions behaved during subsequent design stages, we analyzed the variance within groups and between groups (ANOVA, power = .98, Effect size = .025). Results indicated that, over the three different design stages, only Competence ($p < .005$, $F = 6.03$, $df = 335$) and Challenge ($p < .001$, $F = 5.37$, $df = 330$) differed significantly. Post-hoc tests (Scheffe) show that these differences are to be found between the Alpha stage and the RC stage. This applies to Competence ($p < .003$) as well as to Challenge ($p < .021$). On average, Competence scores were lower during Alpha testing ($M = 2.73$, $S.D. = .13$) than

during RC ($M = 3.26$, $S.D. = .09$) testing while scores for Challenge were higher for Alpha testing ($M = 2.05$, $S.D. = .11$) compared to RC testing ($M = 1.72$, $S.D. = .07$). Learning is marginally significant ($p < .065$, $F = 2.80$, $df = 329$) but differences for the design stage are situated between Alpha and Beta where average Beta scores ($M = 2.95$, $S.D. = .08$) were higher than Alpha scores ($M = 2.79$, $S.D. = .09$).

Classroom Comparison

To check if our sample size was big enough to execute an ANOVA with 22 groups, we performed a power analysis. With a power of .77 we were only capable to reliably detect large or, to a lesser degree, medium differences. Notwithstanding our relatively low power, a considerable number of dimensions proved to differ significantly between classrooms (Competence, $p < .001$, $F = 2.317$, $df = 335$; Vividness, $p < .012$, $F = 1.880$, $df = 330$; Challenge, $p < .020$, $F = 1.784$, $df = 330$; Negative Affect, $p < .000$, $F = 3.428$, $df = 338$; Positive Affect, $p < .000$, $F = 2.684$, $df = 335$; Affective Gaming, $p < .000$, $F = 2.234$, $df = 329$; Learning, $p < .011$, $F = 1.900$, $df = 329$; Negative Experience, $p < .000$, $F = 2.642$, $df = 329$). Only Immersion, Positive Experience and Returning to Reality do not differ. Regrettably, we did not have enough data at our disposal to identify differences between individual classrooms. Furthermore, classroom is a level 2 unit. By using an ANOVA we do not know whether the differences we found are related to the different compositions of the classrooms (e.g. more females in some classrooms) or if they were caused by level 2 variables (e.g. a positive group atmosphere).

Conclusion / Discussion

The testing of PING yielded some interesting results. A first remarkable outcome is the fact that there is a strong effect of the game experience on perceived

learning which confirms that a positive, enjoyable game experience contributes to the experience of perceived learning (H2).

When it comes to the game experience and the different design stages, only Competence and Challenge differ significantly between the Alpha and RC stage. When we add the fact that, first of all, variation in Challenge was not explained by the game experience but shared unexplained variation with Competence (-.57), and secondly, that one of the two major changes during the design stages pertains to the usability of the game (navigation), some interesting assumptions can be made. On theoretical grounds, both Competence and Challenge can be connected to usability issues in terms of effectiveness and efficiency. As such, usability can be considered as a prerequisite for a good game experience but it is not equal to it. Hence, it is possible that Challenge (or the way it was operationalised) is actually a measure of usability. This would explain why it failed to fit in our game experience construct while still being related to it. Furthermore, this could also explain some of the error variance of Competence. As such, we did not find a significant positive change in the game experience during the different design stages (H1) but we did find a significant change in the experienced usability of PING.

Although there is a positive effect of the game experience on Learning, the change is only marginally significant between the Alpha and Beta stages of the game. This significance is probably due, however, to the fact that the Beta stage had some atypical distributions. When checking for interaction effects with Gender of Educational level by means of a multivariate analysis the difference in Learning ceased to be (marginally) significant. The fact that perceived learning does not change positively during the subsequent design stages (H3) is surprising. Especially because the storyline was one of the major changes in the design flow. Furthermore, students were allowed to play the Beta and RC versions longer than the Alpha version which could have resulted in a better learning experience. On the other hand, this finding is not illogical if we take our serious game experience model into account. As most of the dimensions do not vary between the different design stages, it is logical that learning does not vary either. More specifically, if the storyline would have changed enough, this would have been reflected in the

concept of Vividness. Consequentially, the experience of perceived learning would have changed too. This indicates that the changes in the subsequent design stages of PING were not large enough to evoke an improved learning experience. Considering the pre-launch status of the game, an interesting starting point could have been to use the GEQ in combination with a validated usability measure. That way, improvements in usability could have been linked to game experience. As such, it would be interesting if future research on video games that are under development would incorporate usability as well as game experience measures.

Finally, it is interesting to see that there seem to exist strong differences between classrooms on most of the game experience dimensions. Perhaps the most remarkable result is that, when gaming, only Immersion does not differ significantly between classrooms. A possible explanation could be that social interaction during gameplay prevents Immersion to go above a certain level while the absence of sounds or music could have been a decisive factor in stimulating social interaction. Equally intriguing is the fact that constructs such as Competence, Vividness, Challenge and Learning seem to have a collective component. With our current dataset, however, we could not explore this further. Future research could consider using focus groups to explain these findings. Another approach might be to use an experimental design in which the content-related variable is manipulated.

As such, using the GEQ for a serious game in a pre-launch status in a classroom context might not be ideal as some of the items are highly context dependent (Flanders versus the Netherlands, education level of respondents, etc.). However, our own proposed model is susceptible to criticism as well. With the exception of Learning, the constructs of our model contain only two or three items. This is barely enough to cover the concepts they intend to measure hence resulting in operational narrowing of the concepts involved. Results also indicate that the concept of Challenge does not fit its theoretical content (conceptual displacement). Moreover, we built the model from the available data. Since our data ensued from one video game only, the possibility exists that our model cannot be generalized. Further testing will reduce uncertainty. However, future attempts to construct a game experience model should try to include concepts

such as Concentration, Feedback, Clear Goals and Control while a model aimed at measuring experiences in a classroom context should try to incorporate a measure that is able to take context effects into account such as the rich diversity of social interactions. Be it in a quantitative way in a serious game experience model or in a qualitative, ethnographic way.

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Figure 1 Serious Game Experience Model

