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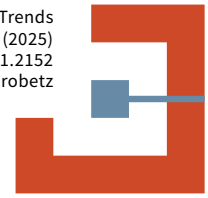

Castledown

Digital games in the language classroom: Designing better curricula through exploratory factor analysis

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Of particular interest for the field of digital game-based language learning is how digital games may affect objective measurements of linguistic growth when employed in the foreign language classroom. Given the substantial selection of digital games, designing an effective digital gaming curriculum can be challenging. In order to address this issue, practical advice based on an exploratory factor analysis of a three-year study examining the pedagogical potential of the narrative-centered game *Life Is Strange* is provided in order to assist foreign language instructors in designing potentially more effective digital gaming curricula which promote desirable testing outcomes, more engagement with digital games in the target language, and increased perception of English growth.

Keywords: DGBLL, EFA, EFL, curriculum design, Life Is Strange

Introduction

Digital game-based learning has largely focused on the mechanics of commercial off-the-shelf (COTS) games (Gee, 2003). The commercial development of games for entertainment has provided a range of immersive experiences for players in many languages, making COTS games particularly appealing for language learners (Thorne & Reinhardt, 2020). Considering the entertainment focus and wide variety of COTS games, creating effective digital game-based language learning (DGBLL) curricula in educational contexts is complex and may benefit from an iterative approach to curriculum design.

Familiarity with different COTS game genres is also not at the same level among students, which may affect their interaction with games used for instruction (Reinders & Wattana, 2015). Similarly, students will also demonstrate mixed levels of proficiency in the target language. Considering that the overall efficacy of DGBLL curricula may be affected by multiple variables such as gaming familiarity and target

language proficiency, multivariate analysis is an appropriate approach to guide iterative curricular design. The following sections will detail a specific example of how this process works.

Method

Research details

The following analysis was based on research conducted with the smartphone edition of the narrative game *Life Is Strange* (Square Enix, 2015). The research examined the viability of narrative-centered, single-player role-playing games to serve as the principal medium of instruction in foreign language classrooms at the university level (Wrobetz, 2022). The following analysis methods, results, and discussions are based on additional data and methodologies not covered in the original research.

Research objectives

The present research focuses on eliciting desirable pedagogical outcomes within the context of DGBLL curricula in English as a foreign language (EFL) classrooms. For the purposes of this research, desirable outcomes are defined as:

1. Objective improvements in English proficiency;
2. Increased levels of engagement with games in English;
3. Increased perception of English growth from gaming.

Research protocols

The research was conducted with an experiment (gaming group, $n = 106$) versus control (non-gaming group, $n = 79$) design; however, the present analysis is based solely on data from the gaming group. Testing protocols (TPs) and survey protocols (SPs) were used to measure how effectively the DGBLL curriculum met the research objectives in the gaming group, focusing on the following 10 variables:

1. Vocabulary growth (TP),
2. Narrative comprehension (TP),
3. Pre-game smartphone gaming engagement (SP),
4. Post-game smartphone gaming engagement (SP),
5. Pre-game perception of games for EFL (SP),
6. Post-game perception of games for EFL (SP),
7. Comprehension of in-game content (SP),
8. Perception of in-game English difficulty (SP),
9. Perception of English growth from gameplay (SP),
10. Playing style (SP).

Statistical analyses

The complexity of interactions among the 10 variables necessitates multivariate analysis. Exploratory factor analysis (EFA) was used to reduce the data's dimensionality

and clarify correlations. With interval data from testing protocols and ordinal data from survey protocols (Likert scales), the sample size (n = 106) and normal data distribution were considered before performing parametric EFA (Sullivan & Artino, 2013). Data were standardized using z-scores, and the Kaiser–Meyer–Olkin test assessed the EFA's suitability. A minimum measure of sampling adequacy (MSA) score of >0.60 was set as the threshold for suitability (Pett et al., 2003). Due to a suboptimal MSA (0.59), an ultra-Heywood case, small sample sizes for some variables, and high multicollinearity, Variables 2, 7, and 10 were removed. The revised seven-variable dataset had an MSA of 0.64 and was deemed suitable for EFA.

The correlation matrix from the seven-variable dataset was used to calculate eigenvalues, which, in turn, determined how many underlying constructs there are. The Kaiser criterion of using eigenvalues >1 as the number of constructs for EFA was employed (Yang & Xia, 2015). Three factors were identified and are summarized in Figure 1. The dataset was then loaded onto the extracted factors with principal axis factoring with orthogonal rotation to maximize the reduction of dimensionality onto shared variance, the results of which are presented in the following section.

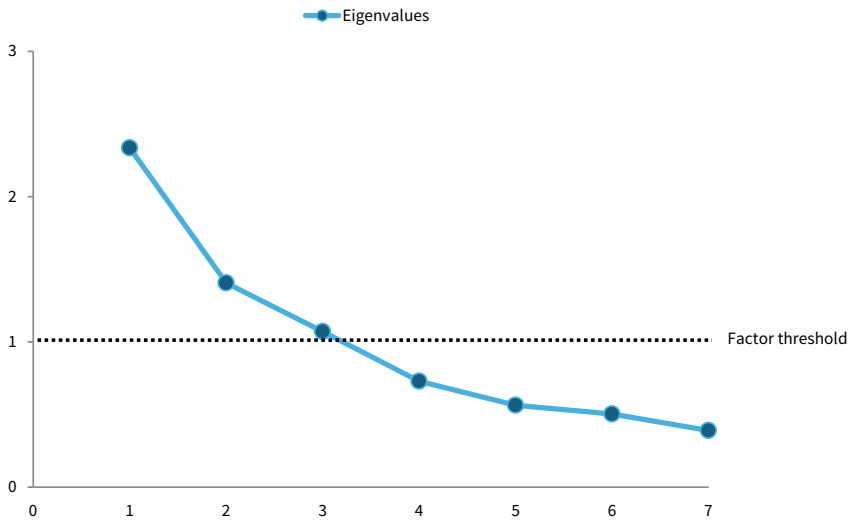

Figure 1. Scree plot of extracted factors

Results

Factor interpretation and loadings

Analysis of the factor loadings identified three constructs: game challenge, familiarity with digital games, and higher initial English proficiency (see Table 1). Students who found the game challenging also found the in-game English difficult but were more likely to perceive improvements in their English. In contrast, students familiar with gaming showed higher pre- and post-game engagement with smartphone games and found the game's English easier relative to students who felt challenged by the game. Lastly, students with higher starting English proficiency scored better on vocabulary tests and found the in-game English less difficult.

Table 1. Summary of factor interpretation and loadings

Variable		Challenge of game	Gaming familiarity	English ability
1	Vocabulary test scores			0.60
2	Pre-game engagement		0.69	−0.15
3	Post-game engagement	0.30	0.71	0.19
4	Pre-game efficacy	0.51	0.15	−0.19
5	Post-game efficacy	0.68	0.15	−0.32
6	English difficulty	0.24		−0.46
7	English growth	0.74	0.14	0.18

Inter-factor correlations

To ensure that each extracted factor represents a standalone construct, it is important to measure inter-factor correlations (see Table 2). The negligible inter-factor correlations demonstrate that the three factors are not significantly correlated with one another and represent a standalone construct underpinning the dataset.

Table 2. Inter-factor correlation matrix

	Challenge of game	Gaming familiarity	English ability
Challenge of game	1	0.15	−0.06
Gaming familiarity	0.15	1	0.03
English ability	−0.06	0.03	1

Model complexity, fit, and variance

The descriptive statistics for the EFA model are summarized in Table 3. Despite the inter-factor correlations being low, the mean item complexity of the model is 1.3. Values over 1 indicate that some variables load strongly on more than one factor, making interpretation more complex. When looking at model fit, a degrees-of-freedom-corrected root mean square of the residuals (df-RMSR) value of 0.04, a likelihood chi-square of 1.53 ($p = 0.67$), and a comparative fit index (CFI) of 0.99 all indicate that the model fits the data well. Threshold values for well-fitted models are <0.05 for root mean square of the residuals, $p>0.05$ for the likelihood chi-square, and >0.95 for the CFI. The Tucker–Lewis index for the model was 1.098, which is slightly above the perfect fit threshold of 1; however, this is likely due to the slightly high mean item complexity value. The comprehensive total of the fit indices nonetheless indicates a model that is well-fitted to the data with the potential for broader generalization to similar demographics.

Table 3. Fit statistics for the model

Fit statistics (n = 106)					
Mean item complexity	1.3	df-RMSR	0.04	Likelihood chi-square	1.53 (p=0.67)
Tucker–Lewis index	1.098	CFI	0.99	Cumulative variance	46.8%

Discussion

The results of this study show how EFA can provide valuable insights into optimizing DGBLL curricula, particularly as an interative process. In the present study, three key factors were identified that influence linguistic outcomes and learners' engagement: (1) game challenge,)2) gaming familiarity, and (3) starting levels of English proficiency. Each of these factors may be leveraged to design effective curricula in DGBLL contexts.

Balancing challenge to optimize learning

Students who felt challenged by the game were more likely to perceive greater levels of English improvement. When structured appropriately, difficulty can facilitate the learning process, an effect which may be maximized by selecting games which cognitively and linguistically challenge players without overwhelming them. For example, games with complex narrative structures can engage the player in linguistic choices, whereas games with adaptive difficulty settings allow gradual skill-building. Effective curricula should ideally pair games tailored to proficiency with level-appropriate vocabulary tests and in-game comprehension scaffolding exercises to strike a balance between difficulty which is productive and difficulty which is discouraging.

Leveraging familiarity to boost engagement

Students familiar with digital gaming were more likely to engage with games both pre- and post-treatment. However, being familiar with gaming was not a significant predictor of vocabulary gains. Effective DGBLL curricula should therefore direct student motivation for playing games toward meaningful interactions for second language acquisition (SLA) purposes, instead of passive consumption. This may be accomplished by having students self-select games in English, making use of English-based communities of play, or by implementing task-based learning exercises like creating game walkthroughs in English which blend target language use and gameplay.

Structuring curricula for differentiating proficiency levels

Higher levels of starting English ability were positively correlated with vocabulary gains but were negatively correlated with perceptions of gaming efficacy for SLA and of English difficulty in the game. The lack of a one-size-fits-all approach to designing

effective DGBLL curricula further highlights the importance of careful game selection and material creation which aligns with the proficiency levels of the class, as discussed earlier. However, in reality, mixed proficiency levels in the classroom makes structuring universally level-appropriate curricula challenging. Educators should therefore err on the side of challenge for game selection and on the side of ease for testing materials while creating an open dialogue with students on why challenges in games benefit SLA. Such an approach may help students maintain engagement with challenging games by providing positive feedback from both testing and lectures that gaming is positively impacting their linguistic abilities in the second language (L2).

Conclusion

This study has highlighted how multivariate analysis such as EFA can help reduce the complexity of designing more effective DGBLL curricula in a balanced and objective manner. More specifically, the results of the analysis demonstrate the potential for delibrate and iterative curriculum design to utilize underlying constructs, such as gaming challenge, students' gaming familiarity, and L2 ability, to enhance desirable pedagogical outcomes such as improved vocabulary acquisition, increased gaming engagement, and positive perceptions of the utility of gaming for SLA. According to the present analysis, the recommendations for educators to create effective DGBLL curricula are to (1) implement challening yet accessible games, (2) leverage gaming familiarity to foster gaming behaviors which promote active L2 use, and (3) apply games challenging enough for students with the highest L2 proficiency and testing easy enough for the lowest proficiency while reinforcing, through lectures, the concept that challenge is beneficial for SLA. Through this iterative process which combines rigorous data collection and multivariate analysis, stronger DGBLL curricula may be created which better capture the underlying classroom dynamics and harness the interactive potential of digital games to create transformative language learning experiences.

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