Gamified Learning as an Intervention for Learning Statistics

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Introduction

Gamified learning may:

- Be comparable to classroom instruction for learning Spanish (Vesselinov & Grego, 2012)
- Be superior to traditional classroom methods in early math education (Bang et al., 2023)
- Reduce intrinsic motivation and, as a result, lower test scores (Hanus & Fox, 2015)

Multidimensional Statistics:

- It is common for *multidimensional* to refer to the number of independent variables and *multivariate* to refer to the number of dependent variables (Wong & Bergeron, 1994)
- Psychologists need multidimensional statistical techniques to handle complex tasks (e.g., ruling out confounders, testing for mediation)

Hypothesis

When compared to classroom lectures alone, gamified learning will predict 1) higher post-test scores and 2) greater test score improvement.

Method

Data and Participants

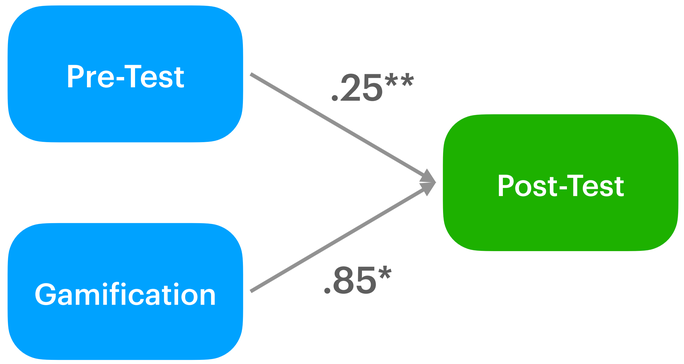
- Data made available on Kaggle by Boboc et al. (2023)
- N = 69 students from the Bucharest University of Economic Studies
- Students enrolled in the Statistics and Economic Forecasting specialization take a required multidimensional statistical analysis course which covers principal component analysis, canonical analysis, cluster analysis, correspondence analysis, discriminant analysis, and panel regression

Participants could self-select to be in one of two groups...

- Experimental: Attend Lectures + Use Gamified App (n = 44)
- Control: Attend Lectures Only (n = 25)
- 15 participants did not have pre-test data and were thus excluded from our analyses
- The gamified app had summaries of the content, flashcards, multiple-choice quizzes, and a point/badge system for the quizzes

Results

Gamified learning predicts ***higher post-test scores*** when controlling for prior knowledge.



Note. Path coefficients represent betas in original units.

Model Fit and Assumption Checks

$F(2, 51) = 6.52$, $p = .003$

$R^2 = .20$, Adjusted $R^2 = .17$

Multicollinearity: All Variance Inflations Factors (VIF) ≤ 1.00

Normally Distributed Residuals: Shapiro-Wilk $W = .98$, $p = .46$

Table 1

Linear Regression Coefficients for Gamification and Pre-Test Predicting Post-Test

Covariate	Beta	95% CI	*p*	Std Beta	Std *B* 95% CI
Intercept	5.08***	[3.83, 6.34]	<.001	–	–
Gamification	.85*	[.04, 1.66]	.040	.26	[.01, .52]
Pre-Test	.25**	[.09, .42]	.004	.38	[.13, .63]

Table 2

Descriptive Statistics of Gamification, Pre-Test, and Post-Test

Variable	1.	2.	3.	*M*	*SD*	*N*
1. Gamification	–			0.76	0.43	54
2. Pre-Test	–.05	–		6.08	2.11	54
3. Post-Test	.24	.37**	–	7.26	1.39	54

*p < .05, **p < .01, ***p < .001

Gamification was coded such that 1 = gamification, 0 = control.
Pre-Test and Post-Test ranges from 0 to 10.
Analyses were computed Using Jamovi (Version 2.6.2.0).
To avoid composite variable bias, we did not use change scores and opted to regress post-test scores on the gamification and pre-test variable (Tennant et al., 2023).

Conclusion

- Gamified learning was significantly associated with higher post-test scores only when controlling for prior knowledge
- Our findings suggest that gamified learning can be beneficial for teaching university-level multidimensional statistics
- Courses may opt to offer optional online review and practice with point systems and badges to increase test scores

Limitations

- **Generalizability:** A small sample (n = 54) from one Romanian university is hard to generalize broadly
- **Gamified App:** Since gamified interventions are heterogenous, it is difficult to tell how these findings would translate for a different gamified app with different features
- **Self-Selection Effects:** It is unclear whether self-selection bias skews our effect (e.g., is differential motivation a factor?)
- **Novelty Effects:** It is possible that the results are exaggerated due to the new and exciting nature of the gamified app

Directions for Future Research

- Future studies can examine other potential benefits of gamified learning (e.g., increased engagement, convenience, knowledge retention, application of skills, freedom to make mistakes, etc.)
- Randomized control trials are needed to assess the true effect of gamified learning interventions
- Meta-analyses are necessary to find the average effect of gamified learning applications and determine what features are most effective in promoting learning

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