

DEVELOPMENT OF GAME-BASED LEARNING MATERIALS FOR LEARNING STATISTICS TO ACQUIRE THE IDEA OF ESTIMATION

Fumihiko Mitsunaga^{1,2}, Hiroki Oura³, Ryo Yoshikawa⁴, and Wakako Fushikida⁵

¹ Nishiyamato Gakuen High School, Nara, Japan

² Yamato University, Osaka, Japan

³ Tokyo University of Science, Tokyo, Japan

⁴ Nagoya Bunri University, Aichi, Japan

⁵ Tokyo Metropolitan University, Tokyo, Japan

fu.mitsunaga@edu.nishiyamato.ed.jp

PURPOSE

In Japan in 2012, descriptive statistics became a required topic in standard high school mathematics curriculum, and hypothesis testing was added as a required topic for inferential statistics in 2022. However, inferential statistics has been positioned as an elective subject or domain. In addition, teachers struggle to teach confidence intervals and hypothesis tests as theories of statistical inference in ways that students can understand. In this study, we designed and developed game-based learning materials that allow students to simulate randomly selected data on a specific case of a social event, as introductory material for each inferential statistics unit in high school mathematics.

DESIGN OF CLASSROOM

Fushikida et al. (2020) defined Epistemic Preparative Activities (EPA) as preparative activities to activate epistemic cognition, which offer promise effective learning for developing conceptual understanding and critical thinking. They confirmed a gradual improvement in students' comprehension by incorporating EPAs before learning in flipped statistics classrooms for university students. Based on these findings, we implemented teaching an inferential statistics class with first-year high school mathematics students using three conditions:

1. A flipped classroom in which students engaged with an EPA using game material (Game Group)
2. A flipped classroom in which students engaged with the EPA using the game material in print form (Paper Group)
3. A flipped classroom without the EPA (Flipped Group)

OUTCOMES (GAME MATERIALS)

Building from the introductory statistics game developed by Oura et al. (2018), the authors constructed a game system and story and lesson content for the game. The game is scenario-based. Students determine the timing of projections for election winners. Statistically, students consider the population and sample and use sampling to make a prediction using confidence intervals. Simulated data are randomly generated at the start of the game using R so that data are not fixed but are simulated at every play. Students use R to calculate descriptive statistics values by playing the game.

IMPLICATIONS FOR THEORY AND PRACTICE

Multiple comparisons were made between the three groups using Tukey's HSD method with SPSS for the difference between the pre- and post-test scores of the same comprehension test minus the pre-test score. The differences between the Game Group and the Paper Group, and between the Game Group and the Flipped Group were significant. (Statistics Game, <https://game.dostat.jp>)

REFERENCE

- Fushikida, W., Oura H., & Yoshikawa, R. (2020). Practice and evaluation of a flipped classroom with epistemic preparative activities on basic statistics. *Japan Journal of Educational Technology*, 44(2), 237–251. <https://doi.org/10.15077/jjet.44054>
- Oura, H., Ikejiri, R., Nakaya, K., Yamamoto, R., & Yamauchi, Y. (2018). Gaming, watching, and practicing: A case study of a learning cycle model in introductory statistics. In J. Kay & R. Luckin (Eds.), *Rethinking learning in the digital age. Making the learning sciences count. Proceedings of the 13th International Conference of the Learning Sciences* (pp. 1507–1508). University College London.