Preparing Students for Learning Statistics with Adventure Game: Learning Cycle Model of Gaming, Watching, and Practicing

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Abstract: Learning statistics is challenging for non-major students. Prior research suggests engaging students in some preparatory activity for them to explore statistical problems with a video game and tangible simulation before providing formal learning resources leads to larger learning gains than the other order. The present study extends this line of theoretical discussion by demonstrating *adventure game* as another suited format for such preparatory activity as part of a learning cycle combined with collaborative formal practice.

Introduction

Learning statistics is challenging for non-major students, and it is a significant goal to develop such instructional theory that helps a wide range of students without a strong mathematics background learn statistics effectively. Literature suggests engaging students in some form of inquiry as a promising approach; some emphasize engaging students in scientific practices (e.g., Lehrer, Kim & Schauble, 2007); some emphasize engaging students in informal statistical inference (ISI) (e.g., Makar, Bakker, & Ben-Zvi, 2011). Another line of research engages students in some preparatory activity for them to explore statistical problems with a deliberately designed video game and tangible simulation designed to prepare them for future learning before providing formal learning resources (e.g., Arena & Schwartz, 2013; Schneider & Blikstein, 2015).

Conceptual framework

Bransford and Schwartz (1999) discussed a point of view of transfer to solve new problems given relevant resources in *Preparation for Future Learning* (PFL). Schwartz and Martin (2004) engaged students in an "invention" activity that they first attempt to invent their own solution for a statistical problem before its brief lecture and individual practice, and demonstrated that students in such condition outperformed those in the "tell-and-practice" condition. Later, Arena & Schwartz (2013) designed an invader game that visualizes probability distributions of invaders and demonstrated consistent results by engaging participants in playing the game and reading expository texts. Schneider and Blikstein (2015) designed a tabletop simulation of permutations and combinations and demonstrated that the "table-and-video-lecture" condition outperformed the "video-lecture-and-table" condition. These suggest that PFL can be characterized by the preparatory stage that engage students in some exploratory activity *before* providing formal learning resources (FLRs). In this study, we propose an *adventure game* as an alternative format for designing such PFL activities combined with another collaborative formal practice (CFP) step after the "PFL-and-FLR" sequence as part of the unit of learning cycle.

Adventuregame for PFL followed by formal learning resource and practice

Adventure game is a popular category in video, computer, and mobile games, which can present various, both real and virtual, and context-rich scenarios to users and engage them in a sequence of questions and answers in the form of problem solving. In the present study, we designed an online adventure game in which students can explore such statistical-problem-solving scenarios (Figure 1). First, users choose a scenario and they are given a background context and its problem such as "Is your friend's coin deceptive?" and "Which store has the longest waiting time?" with answer options aimed to engage them in informal statistical reasoning (Table 1). To solve the problems, users go to the investigation mode in which they collect sample data by choosing a sample size (N=10, 100, or 1000) and interpret the histograms from randomly varied but computationally controlled population distributions. Based on their own reasoning with the graphs, users choose their answer and the subsequent story acknowledges them if and how their choice was correct in the scenario context or not. After exploring the probabilistic phenomena and activating their prior knowledge, they are provided with FLR such as lectures and the videos, and this "PFL-and-FLR" sequence is expected to lead to better learning gains than the other order as discussed in aforementioned studies. In addition, we also stress the third step of CFP as part of the unit of learning cycle. CFP refers to such activity that students collaboratively work on conceptual and mathematical tasks that help students practice their formal knowledge and skills after the FLR step (Figure 2).

Such collaborative exercise step has not been stressed as part of the unit of learning cycle in prior studies, but it will help students develop their conceptual understanding and its application skills through the exercise step.

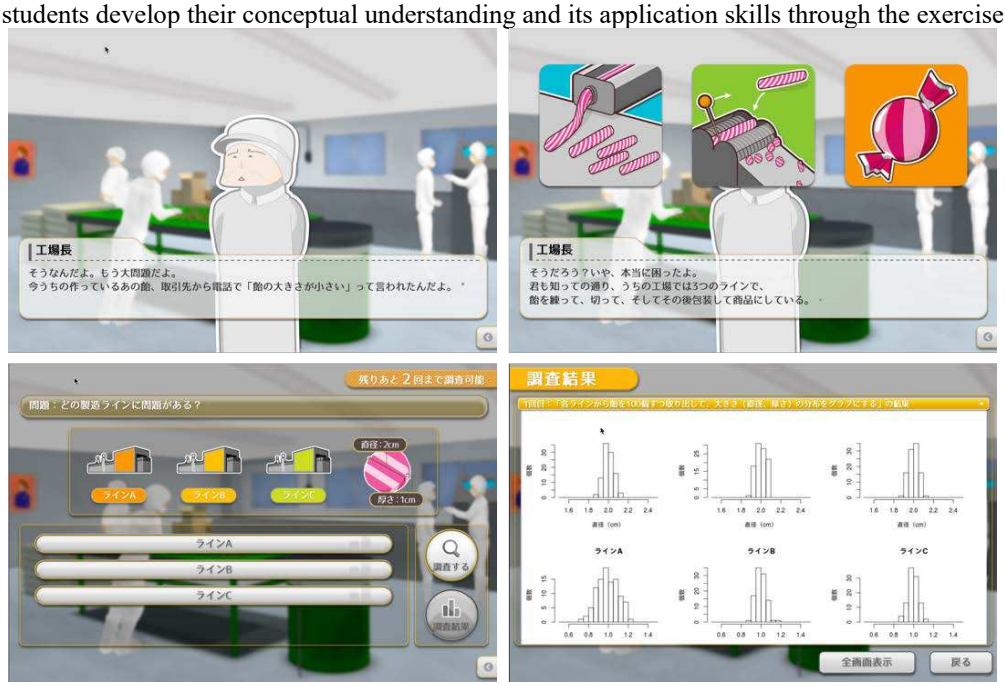

Figure 1. Screen Captures of the Adventure Game—top left and right: presenting the background context (candy factory scenario), bottom left: presenting the problem and answer options (Line A, B, and C), and bottom right: histograms in the diameter and thickness of a candy (Line A has a larger variance in thickness than other lines).

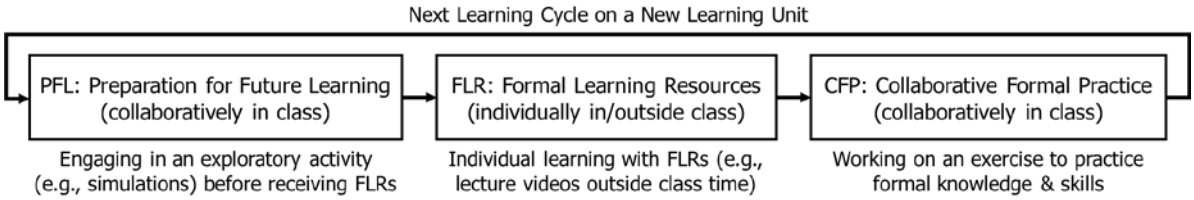

Figure 2. The Learning Cycle Model of PFL, FLR, and CFP Steps Drawing from the PFL Framework

Future work

The present study illustrated a learning cycle model with the adventure game followed by formal learning resource and collaborative practice. This study is still in a preliminary stage and a comparative experiment is going to be held to test effects of the adventure game on learning gains and processes in the near future.

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