

Work in Progress: Leveraging Game Learning Analytics for Engineering Faculty DEI Training

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Introduction

As gaming gains traction in adult education, there is both an opportunity and a need to utilize this interest for innovative and engaging faculty development purposes [1]. For learning games to reach their full potential, the data produced by these games should be analyzed to make improvements to the game and assess users' learning. Since each game produces unique types of data and requires different interpretive approaches, a universal method for analysis does not exist. This underscores the need to create a customized data analysis system for analyzing gaming data that can be used for this project and other games in the future. This paper presents an overview of the game's design, its data collection process, the development of a customized analysis workflow, and the broader implications of this approach.

Background

Data science methods are becoming increasingly integrated into game learning analytics of serious games. Alonso-Fernández and colleagues describe "serious games" as games with a purpose beyond simply entertaining the user – but also to teach or enlighten them about a topic [2]. Collecting, analyzing, and interpreting the data created from users completing these types of games is necessary for understanding the users' learning and to make improvements informed by the data. Alonso-Fernández classifies this process as game learning analytics (GLA), and describes it as "the collection, analysis, and extraction of information from data collected from serious games" [3]. GLA can be used to inform further work and ensure the game remains effective and adaptable for its goals. Ultimately, GLA contributes to a better understanding of how users interact with and learn from gaming platforms developed for learning.

We developed a gaming platform as an innovative tool to support engineering faculty in exploring diversity, equity, and inclusion (DEI) concepts in a safe, interactive environment. The larger project encourages users to reflect on their personal values and how these values about DEI influence their professional activities including interactions with students and colleagues with marginalized or non-centered identities. Our proprietary game was developed by a gaming company on a platform that features scenario-based learning [4], where players must select a response option that is informed by differing values and beliefs related to DEI issues. The gameplay data by itself is not sufficient to answer the research questions for the larger project, emphasizing the need for follow up data collection to augment the gameplay data for each player. However, for the purpose of this paper we will focus on the coding development to convert the gameplay data into scores that can be statistically evaluated and compared to existing research data on the constructs of interest.

Methods

Data

The primary data consists of user-selected responses to scenario-based prompts within the game. To interpret these responses, we developed a coding scheme informed by previously validated scales, including the Personal Values scale [5], Diversity perceptions scale [6], the White Privilege Awareness scale [7], the Colorblind Racial Attitudes scale [8], and the Homophobia scale [9]. These were adapted to connect the user's response data to the survey data as part of the larger study. We modified the scales for the context of the current study to operationalize each construct based on the established scale range and scoring approach. A score was assigned to each of the three categories or constructs of interest for the study: reputation, student academic achievement, and inclusiveness. Each scenario included four potential response options and when a scenario was not applicable to a particular construct, a score of zero was assigned. Table I in the Appendix illustrates this scoring approach.

The established table of expanded scale scoring will be used as the input to process the data for analysis using MATLAB and statistical software SPSS. The data generated from each user's gameplay is compiled into a comma separated values (CSV) file. Each row includes: the scenario number, the short title of the scenario, the text of the response chosen, and the time (in minutes and seconds) it took the player to choose a response. Time is measured from when the scenario is first presented to when the player selects the response. Lastly, the data file includes the final cumulated scores for the constructs of interest for the study: reputation, student academic achievement, and inclusiveness.

Our approach for the gaming data mining began with examining pilot data collected during the initial playtest conducted during the game development process. The game development process included multiple phases that tested various aspects of the game. For example, how the scenario and the response options were presented to the user was tested to optimize the player experience. The pilot players provided feedback on all aspects of the game, including the wording of scenarios, the visual appeal of game characters, and the execution of the game play options.

Code Development

The goal of this MATLAB code is to efficiently load in and assign the additional scale values to each player's game data to allow for a more complete analysis. The code begins by creating a mapping table, which is used to provide the pre-determined numerical value to each response option across each construct of interest. User gameplay files—each associated with a unique, anonymized identifier—are loaded into MATLAB as structured tables. The script then matches each scenario-response pair to the appropriate score(s) from the mapping table, populating new columns in the user's data file with these scores. This updated dataset can then be used for statistical analysis, either within MATLAB or exported to another software.

Code Applications

The application of this MATLAB code can be used to analyze and visualize game users' data in multiple ways. Basic descriptive statistics can reveal trends in individual users' data or across groups from different institutions or regions. Additionally, categorical analysis methods can be used to more closely examine the differences in scores across different groups. More generally, analysis of the data will provide insight into participants' experiences and interpretations of the DEI concepts presented.

After enough data has been collected to make comparisons, visualization techniques can be utilized to more clearly demonstrate the similarities or differences among different user groups. For example, histograms can show the frequency with which a certain response is chosen for a given scenario and provide an understanding of how people are most commonly responding to certain situations, allowing for more targeted feedback and interventions. Box and whisker plots provide insights about the quartiles of the data and can help identify any outliers. These outliers can be helpful indicators of any strong behaviors or thinking patterns that should be addressed through specific interventions.

Conclusion

This work-in-progress study demonstrates the value of using GLA to assign meaning to game data by describing the steps our research team took to create a MATLAB code to clean, organize, and visualize the data produced from a learning game. In describing the code's structure, we hope to provide a guide for other researchers aiming to leverage serious games for their own objectives. The development of a customizable data analysis tool offers the opportunity for researchers across various disciplines to collect and interpret meaningful insights from game-based learning interventions. The ability to make evidence-based improvements both to the game and to faculty development demonstrates the effectiveness of game-based learning interventions for adults, which are key goals of the larger project. Details of our method developed to analyze data from a learning game are shared to inform others who may be pursuing a similar adult learning project. Accessing and analyzing the data from such a game is vital for making improvements and gaining an understanding of its impact.

Future Work

The paper describes a single step of the larger research project. The project's next steps are to continue pilot testing the game and to establish the necessary storage systems for secure handling of gameplay data. Following this, we will integrate and compare the gameplay data with users' DEI survey responses. Additional data sources, such as post-game reflections and semi-structured interviews, will be used to compare and add depth to the generated gaming data. As a result, the combined data from this mixed-methods approach will provide a comprehensive and holistic view of each participant's perceptions of DEI topics across timepoints. A careful comparative analysis of individual and group-level changes will be critical for identifying patterns and informing next steps for targeted interventions. Additionally, expanding the study to include more diverse participant groups and institution types will provide a deeper understanding of factors that influence gameplay decisions and DEI perceptions. These insights can guide more tailored intervention strategies and iterative

improvements to the game design.

Looking beyond the immediate scope of this project, the flexible coding and analysis system we have developed has potential applications for a broad range of adult education games across different content areas. Continued use of this framework to analyze future game users' data will likely illuminate additional areas for refinement and suggest new directions for serious games in faculty development. In the long term, our overarching goal is to establish a scalable, evidence- based framework for employing serious games as a tool to support inclusive teaching practices in higher education.

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Scenario Description	Responses	Representation Score	Student Success Score	Inclusion Score	Personal Values Score (1-6)	Diversity Perceptions Score (1-7)	White Privilege Awareness Score (1-6)	Colorblind Racial Attitudes Score (1-6)	Homophobia Scale (1-5)
Morgan confides that their previous work experiences as an LGBTQ+ individual were hostile. They share that it made them feel engineering workplaces weren't welcoming or safe spaces for people like them.	Reassure Morgan that attitudes are changing, and many engineering workplaces now embrace LGBTQ+ inclusion.	0	0	-10	0	0	0	0	4
	Acknowledge their experience, offering to discuss any specific concerns they have about this environment.	0	0	10	0	0	0	0	1
	Point out that not every workplace is the same, and some places can still be challenging for LGBTQ+ individuals.	0	0	5	0	0	0	0	3
	Express empathy, adding that adapting to each workplace may help with long-term success.	0	0	-5	0	0	0	0	3