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Developing a Visualized Data Guessing Game to Assess Data Literacy

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Abstract: As the volume of information grows exponentially, data literacy has emerged as an essential skill in contemporary society. However, most existing assessment methods are traditional, lack interactivity and engagement, and fail to provide insights into the learning process. While previous approaches to data literacy have primarily emphasized data collection and organization, visualization has often been limited to converting data into charts without profound interpretation. Therefore, this study aims to develop a 'data guessing' game system rooted in visualization to assess users' data literacy comprehensively.

Keywords: Data literacy, data visualization, gamification, learning analytics, educational assessment

1. Introduction

This system not only evaluates users' data literacy but also collects gameplay records for subsequent learning analytics. Developed with Flutter, the research explores the influence of gamification design integrated with constructivist learning theories on user motivation and learning efficacy.

The innovation of this study lies in integrating gamification elements with data literacy assessment, providing an interactive platform that bridges the gap between traditional assessment methods and engaging learning environments. Unlike existing methodologies, our game system offers a novel approach by focusing on the interpretation of visualized data, encouraging users to actively construct knowledge through gameplay.

2. Discussion

The subjects of this study were college and university students, including master's and doctoral students. A total of 60 participants were successfully recruited, comprising 34 males and 26 females, with an average age of 22.03 years. The experimental procedure is divided into three stages:

1. Pre-Test Stage: Participants' basic information was collected, and pre-tests were conducted to assess prior knowledge, visual data literacy skills, math anxiety, learning motivation, and self-efficacy. Validated instruments such as the Data Literacy Assessment (DLA) and the Mathematics Anxiety Rating Scale (MARS) were used to ensure reliability and validity.
2. Gameplay Stage: Participants engaged with the visual data guessing game, which incorporated gamification elements like points, badges, and leaderboards to enhance motivation and engagement, grounded in Self-Determination Theory (SDT) and Flow Theory. Gameplay data, including responses to various visual data interpretation tasks, were collected for subsequent analysis.
3. Post-Test Stage: Post-tests using the same instruments as the pre-tests were administered to assess changes in math anxiety, visual data literacy skills, learning

motivation, and self-efficacy. Robust statistical analyses, including paired t-tests and effect size calculations, were conducted to evaluate the significance and practical implications of the findings.

Learning analytics were performed by analyzing participants' guessing data for each question—including correlation coefficient graphs, correct answers, guessed answers, and correctness. This analysis provided insights into participants' learning progress, identified specific number ranges or graph shapes where participants tended to make mistakes, and informed adjustments to the learning content accordingly

3. Results and Conclusion

The results of this study indicate that playing the visual data guessing game significantly enhanced participants' visual data literacy skills, as evidenced by a statistically significant improvement in their average scores ($p < 0.05$). The game effectively reduced math anxiety levels ($p < 0.05$), suggesting that the interactive and engaging nature of the game alleviated anxiety toward math learning, thereby increasing learning motivation and engagement. Participants also showed a notable increase in self-efficacy ($p < 0.05$), which is crucial for shaping their learning attitudes and confidence.

These findings highlight the potential of the visual data guessing game as an educational tool. It not only improves participants' prior knowledge and visual data literacy skills but also reduces their math anxiety levels while enhancing their learning motivation and self-efficacy. The integration of gamification with learning theories provides a strong educational framework that substantiates the game's effectiveness.

Implications for Educational Practice: By offering an engaging and interactive assessment tool, educators can better evaluate and enhance students' data literacy skills in real-world settings. The game can be integrated into curricula to stimulate learning interest and active engagement, ultimately improving learning outcomes in the domain of data literacy. Future research with larger sample sizes and diverse populations is recommended to generalize these findings further.