Gameful Experience of Escape Rooms: Insights from Multidimensional Scaling

Abstract (120)

This study explores the efficacy of educational escape rooms compared to traditional assessments in nursing education, using one-way ANOVA and Multidimensional Scaling (MDS) analysis to evaluate student experiences. The research compares traditional assessments, standard escape rooms, and redesigned escape rooms incorporating gamified features and instructional design elements. Findings indicate that playfulness, immersion, and guidance significantly improved through the redesign process. The integration of MDS with traditional statistical methods provides a comprehensive view of students' perceptions, highlighting the potential of leveraging diverse analyses to interpret educational data. Future research should include diverse data sources like video recordings and interviews to capture the full scope of student interactions and optimize escape room learning environments.

Body Text (2000)

Introduction

This study investigates the efficacy of educational escape rooms as an alternative to traditional assessments in nursing education. By utilizing Multidimensional Scaling (MDS) analysis, the study will compare nursing students' perceived learning experiences across three assessment formats: traditional assessments, standard escape rooms, and redesigned escape rooms. Traditional assessments typically focus on skill demonstration but often lack engagement (Roman et al., 2020). Escape rooms offer dynamic, immersive environments fostering teamwork and problem-solving (Reinkemeyer et al., 2022). Furthermore, the escape rooms redesigned in this study enhance educational outcomes by incorporating instructional design elements such as gamified features, visual aids, and contextually relevant scenarios based on the ARCS theory. This research aims to provide insights into optimizing alternative assessment methods through thoughtful instructional design, ultimately enhancing student learning experiences and informing the development of more effective assessment strategies in nursing education.

Background

Multidimensional Scaling

Multidimensional Scaling (MDS) is a statistical technique for exploratory data analysis and dimension reduction, quantifying similarity judgments from direct ratings or indirect measurements like perceptual confusion (Hout et al., 2013). MDS spatially maps relationships among items, with similar items placed closer together and dissimilar items farther apart. This spatial representation helps researchers infer underlying dataset dimensions or confirm hypotheses by examining the spatial organization. The technique effectively conveys relational information, with the layout of dimensions being inconsequential to its utility.

MDS has applications beyond psychological research, extending to social sciences, scientific visualization, data exploration, pattern recognition, and analyzing natural phenomena such as earthquakes and forest fires (Saeed et al., 2018). In psychological studies, MDS represents

interrelations between objects, identifies underlying data dimensions, and highlights individual or group differences (Jaworska & Chupetlovska-Anastasova, 2009). It is particularly suitable for studying subjective phenomena like emotions. For example, Izmailov and Sokolov (1999) used MDS to analyze how subjects evaluated differences between schematic faces representing various emotions. The data were plotted in a hypothetical spherical space with dimensions of emotional tone, intensity, and saturation, showing a close association between visual stimuli (emotional faces) and semantic labels (emotion words).

Interpreting MDS results is inherently subjective, requiring analysts to examine spatial organization and infer primary similarity dimensions. For instance, if dogs and cats are mapped close together but distant from wolves and tigers, domesticity might be inferred as a significant similarity dimension. Interpreting MDS solutions necessitates careful consideration since psychological data are rarely straightforward, and similarities can stem from numerous arbitrary features. Despite its subjective nature, MDS's flexibility in exploring complex, multidimensional data is both a limitation and a strength. Overall, MDS is a robust method for uncovering underlying structures in diverse datasets, making it valuable for scientific and practical applications.

ARCS Theory and Escape Room Design

The redesign process of the escape rooms for this study was founded on a seminal work by Keller (1987), which suggested a motivational framework in instructional design that focuses on four key elements: attention, relevance, confidence, and satisfaction. Attention involves capturing and maintaining learners' interest through varied stimuli, challenging questions, humor, or surprising facts. Relevance ensures the material is perceived as important and useful by relating it to learners' existing knowledge, showing practical applications, and aligning it with personal goals. Confidence is built by helping learners believe in their ability to succeed, setting clear goals, providing positive feedback, and gradually increasing task difficulty. Satisfaction is achieved by providing a sense of achievement and rewarding efforts through intrinsic and extrinsic rewards, opportunities to apply learning, and ensuring an enjoyable experience. Together, these components enhance motivation and learning outcomes. After running the standard escape room in the summer and reflecting on students' feedback, we contended that it could be improved to promote more attention and confidence. Based on the design strategies suggested by Keller (1987), we changed the escape room design for the fall cycle (See Table 1).

Method

Research design

This exploratory study aims to compare the efficacy of three different forms of assessments in evaluating student learning outcomes: traditional assessments, a standard escape room, and a redesigned escape room. All three assessments were designed around four critical themes of medication, patient safety, blood sugar, and sepsis, with identical skill sets to be performed. While a teaching faculty designed the standard escape room with clinical narratives, the redesigned escape rooms were revised based on Keller's ARCS theory (Keller, 1987).

Participants

The participants are first-year nursing students taking a simulation-based introductory course in nursing. A total of 205 students at a public university located in the southern United States were selected. The study was conducted over two semesters. Participants in the study were divided into three distinct groups, each experiencing one of the assessment methods. 69 students went through the standard escape room in the summer of 2023, 66 students went through the redesigned escape room in the fall of 2023, and 70 students went through a traditional assessment of demonstration in the fall of 2023. Due to administrative constraints, random assignment was not feasible, potentially introducing selection bias. Nonetheless, efforts were made to ensure that the groups were comparable regarding demographic and academic characteristics. The study went through internal IRB approval.

Settings

For both summer and fall semesters, the escape room activity comprises four rooms, each with a distinct theme: medication, patient safety, low blood sugar, and sepsis. The entire intervention was overseen by the game master, who included the lab instructor, the course instructor, and two senior mentor students. Participants had fifteen minutes per room to complete the tasks and could ask any game master technical questions. While the game masters avoided giving direct answers, they facilitated progress by prompting the patient's assessment or checking the students' understanding and background knowledge. Students were equipped with a scorecard, a pencil, and a stethoscope. Teams of two to three students worked together to solve the challenges in each room and rotated every 15 minutes to ensure all four rooms were experienced. Each room could earn up to 10 points, with one point deducted for every unmet requirement when time expired.

Measures

We collected questionnaire responses from students after they finished the formative assessments. A gameful experience questionnaire (Högberg et al., 2019) was adopted to explore students' perceptions of the escape rooms. As the escape rooms in this study did not have any competitive treats, the questionnaire adapted for this study consisted of 47 items under six categories: accomplishment (Cronbach's $\alpha = 0.91$), challenge ($\alpha = 0.90$), guidance ($\alpha = 0.90$), immersion ($\alpha = 0.89$), playfulness ($\alpha = 0.87$), and social experience ($\alpha = 0.96$) (Högberg et al., 2019, p. 639). The questions were on a 7-point Likert scale.

Analysis

We analyzed the survey data using MDS and one-way ANOVA to compare the differences in the gameful experience of the three groups—a posthoc power analysis of one-way ANOVA at the alpha level of 0.05 with the sample size per group of 70 resulted in 0.45 for accomplishment, 0.25 for challenge, 0.84 for guidance, 0.94 for immersion, 0.70 for playfulness, and 0.60 for social experience, respectively.

Results

The one-way ANOVA showed a significant difference in overall gameful experience across the groups ($F(2, 199) = 6.223$, $p = .002$). The redesigned escape room scored significantly higher score in GamefulQuest compared to the traditional assessment ($p = .002$, 95% C.I. [-.736, -.138]) and but not compared to the standard escape room ($p = .208$). The escape room also did

not significantly differ from the traditional assessment (p = .287).

The notable differences emerged especially from guidance (F (2, 199) = 5.490, p = .005), immersion (F(2, 199) = 7.358, p <.001), and playfulness (F(2, 199) = 3.788, p = .024). Similar pattern is observed in the multidimensional scaling (Figure 1), which shows P (playfulness) and G (guidance) being scattered farther from one another than other constructs, such as A, C, or SE.

Discussion

The results from one-way ANOVA and MDS showed significant improvement of students' gameful experience after the redesign process, especially in guidance, immersion, and playfulness. This underscores the importance of integrating instructional design principles in designing engaging learning experience.

While the three facets were proven to be significant in the traditional statistic test, immersion showed consistent position on the MDS coordinates across different groups. We assume the absence of immersive technology may be the cause. Despite integrating instructional design principles, without advanced technologies such as virtual reality, the depth of immersion may not significantly differ from traditional assessments. However, it is consolidated that elements of playfulness and guidance were notably impacted by instructional design by both one-way ANOVA and MDS. These findings underscore the critical role of thoughtful design in enhancing the educational effectiveness of escape rooms. By integrating gamified features, clear instructions, and contextually relevant scenarios, we can significantly boost engagement and learning outcomes.

The comparison of traditional statistical methods with Multidimensional Scaling (MDS) analysis provided new insights into students' learning experiences. While traditional statistics offer valuable quantitative measures, MDS allowed us to visualize and interpret the multidimensional nature of students' perceptions more effectively. This methodological blend highlights the interdisciplinary nature of advanced instructional strategies and underscores the necessity of co-designing educational interventions. Collaboration between educators, designers, and researchers is essential to create optimized learning environments that cater to diverse student needs.

Our reliance on survey data is a limitation of this study. Surveys provide valuable self-reported insights but fail to capture the full scope of student experiences within the escape room. To gain a more comprehensive understanding, future research should incorporate diverse data sources, such as video recordings and interviews. These qualitative data can reveal nuanced aspects of student interactions and behaviors, offering deeper insights into how escape rooms can simulate engaging and effective learning environments. Ultimately, this approach can guide the development of more robust, evidence-based instructional designs that maximize the potential of escape rooms in education.

Conclusion

This study highlights the importance of instructional design in enhancing playfulness and guidance in educational escape rooms. Future research should incorporate diverse data sources to better understand and optimize these engaging learning environments.

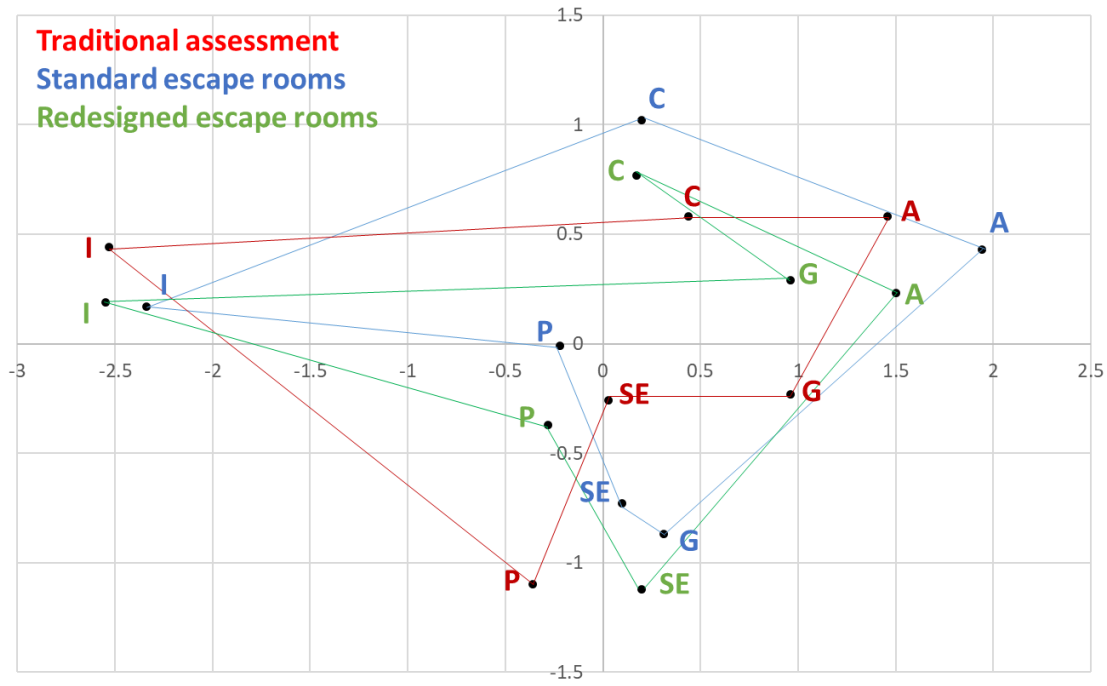
Table 1. *ARCS Design Strategies and Escape Room Redesign ARCS*

Design Strategies (Keller, 1987)	Escape Room Redesign
C1.1. Incorporate clearly stated, appealing learning goals into instructional materials.	Have clearly visible step-by-step instructions. Originally, the instructions were written in a small card that students sometimes overlooked.
A6.1. Use games, role plays, or simulations that require learner participation.	Have more game-like elements. Originally, the escape room had few game features except for the time limit.
C5.2. Have students learn new skills under low-risk conditions but practice the performance of well-learned tasks under realistic conditions.	Have game masters consistently oversee the rooms. Originally, the game masters circled the four escape rooms and were not always readily available.
A2.1. Show visual representations of any important object or set of ideas or relationships.	Have manipulatives such as locked boxes. Originally, the information was provided verbally by game masters when the students successfully finished the patient assessment.
C4.2. Encourage student efforts to verbalize appropriate attributions for both successes and failures.	Share the information about students' performance (i.e., remaining time) immediately. Originally, the gameplay information was not shared with students unless they exceeded the time limit.

Table 2. *One-way ANOVA on GamefulQuest Survey Data*

		Sum of Squares	df	Mean Square	F	Sig.
Accomplishment	Between Groups	2.831	2	1.416	2.239	.109
	Within Groups	125.792	199	.632		
	Total	128.623	201			
Challenge	Between Groups	1.716	2	.858	1.074	.344
	Within Groups	158.996	199	.799		
	Total	160.712	201			
Guidance	Between Groups	10.912	2	5.456	5.490	.005
	Within Groups	196.767	199	.994		
	Total	207.679	201			
Immersion	Between Groups	19.389	2	9.695	7.358	<.001
	Within Groups	260.866	199	1.318		
	Total	280.255	201			
Playfulness	Between Groups	7.695	2	3.847	3.788	.024
	Within Groups	201.090	199	1.016		
	Total	208.785	201			
Social Experience	Between Groups	6.517	2	3.258	2.994	.052
	Within Groups	215.452	199	1.088		
	Total	221.969	201			
Total	Between Groups	6.493	2	3.247	6.223	.002
	Within Groups	103.824	199	.522		
	Total	110.317	201			

Figure 1. *Multidimensional Scaling (MDS) of the GamefulQuest Survey Data*



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