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# Student feedback guides the development of a microbiome card game "No Guts No Glory"

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**Abstract**

**Introduction:** We frequently associate microbes with infection, rarely expounding on their usefulness and importance to healthy development. For humanity to leverage these microbial "super powers", learners from all backgrounds need to appreciate their utility and consider how microbes could help solve some of the most critical problems we face. However, learners are frequently uninterested or intimidated by microbiology. The card game "No Guts No Glory" was created to engage students by piquing curiosity and encouraging informal learning to change perceptions and advocate the value of microbes to good health.

**Methods:** Undergraduates from various faculties in the National University of Singapore were invited to play and give feedback on accessibility, engagement and self-reported learning gains.

**Results:** The game was well-received across disciplinary backgrounds with positive feedback (5-point scale) on game mechanics being fun (4.17±0.63), attractive artwork (3.83±1.00) and scientific snippets (3.79±1.04), positive re-playability (3.46±0.84), player engagement for those without foundational knowledge in microbiology (3.63±1.04), and usefulness of knowledge taught (3.54±1.10). Areas for improvement evidenced from feedback included unclear instructions (2.74±0.98), limited content taught (2.76±0.93), not generating interest to attend formal microbiome classes (2.88±1.17) and not prompting lifestyle changes (1.98±1.11).

**Conclusion:** This pilot study provided valuable insights from the target demographic, with concrete ideas on how to improve the educational potential of "No Guts No Glory". Findings further lay the groundwork for the design of future instruments to objectively quantify learning gains from gameplay.

**Keywords:** *Game-based Learning, Microbiome, Microbiology, Card Game, No Guts No Glory*

## I. INTRODUCTION

Though responsible for infection and disease, microbes are also necessary for promoting and maintaining good health and are remarkably useful in many industries. Microbes are crucial and versatile tools which can be used to tackle some of the world's most complex problems ranging from pandemics and climate change to sustainable foods and environmental remediation (Akinsemolu, 2018). Recognising the true potential of microbes could encourage their use in impactful problem-solving. However, students may perceive microbiology as a difficult subject and not associate microbes with anything positive. To address this, we developed the card game "No Guts No Glory" that

focuses on the positive aspects of microbes, particularly in the context of the gut microbiome which is closely tied to many aspects of our health and development (Lynch & Pedersen, 2016). We sought to engage learners from diverse disciplines by reducing the psychological barrier to learning microbiology, sparking curiosity and encouraging self-directed exploration.

Previous studies on card games, including one involving immunology (a related and equally complicated subject), have demonstrated the benefits of game-based learning (Barnes, 2022; Su et al., 2014): (a) games provide an attractive, innocuous entry point for individuals to explore complex subjects in a fun and enjoyable manner;

(b) they remove barriers associated with traditional learning approaches, making it easier for learners to get started and actively participate; (c) additionally, game-based learning promotes active engagement; (d) through interactive gameplay, players become immersed in theoretical concepts which fosters deeper understanding of the subject and enhances retention.

In this study, we examined the impact of playing "No Guts No Glory" on participants' interest in microbiology and garnered feedback for optimising game mechanics, instructions and artwork in preparation for future studies on the game's impact on learning gains.

## II. METHODS

Undergraduate students from various academic backgrounds were invited to participate in this pilot study on version 1 of the microbiome card game "No Guts No Glory". Students were briefed on the details of the study and implied consent was given with their participation. Documentation of informed consent was waived as the collection of personal, sensitive information was kept to a minimum. A total of 41 participants were recruited – 29% from Medicine, 46% from Life Sciences, 20% from Psychology and 5% from other majors. Although not enforced, most participants played the game with others from the same discipline due to the way participants were recruited and how gameplay sessions were organised.

Participants first read through the game instructions and provided feedback on the instructions before playing two rounds of the game in groups of three or four. During the first round of gameplay, participants discussed and negotiated the rules among themselves based on what they had read, without input from the session facilitator. There was a break between the two rounds when the session facilitator highlighted deviations from the intended gameplay and answered questions about the game, before proceeding to the second round of gameplay. Participants then gave feedback via Qualtrics on their experience with the game. Throughout the two rounds of gameplay, the session facilitator also recorded observations of questions about instructions, disagreements about rules, deviations in gameplay and comments about game mechanisms, artwork, experiences and learning gains.

For quantitative feedback, participants rated the clarity and presentation of the instructions, the accessibility of the game, player engagement level and perceived learning gains, based on 5-point rating scales. Open-ended qualitative questions included: 1) suggestions to improve the instructions or the game, 2) elaboration on likely lifestyle/behavioural changes after playing and 3) key ideas they had learnt about the gut microbiome.

## III. RESULTS

Quantitative feedback from participants after playing "No Guts No Glory" is summarised in Table 1 and qualitative feedback (individual comments and suggestions) is accessible at

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Table 1. Participants' quantitative feedback (5-point rating scales) on the microbiome card game "No Guts No Glory"

| Instructions | Scale | 1 | 2 | 3 | 4 | 5 | | Mean score (number of respondents) | SD |
|---|---|---|---|---|---|---|---|---|---|
| Ease of understanding [a] | Not easy | 10.5 | 29.0 | 39.5 | 18.4 | 2.6 | Very easy | 2.74 (38) | 0.98 |
| Design/Presentation [a] | Did not like | 7.9 | 18.4 | 39.5 | 23.7 | 10.5 | Like very much | 3.11 (38) | 1.09 |
| **Accessibility/player engagement** | | | | | | | | | |
| Length of game | Too short | 0 | 7.3 | 82.9 | 9.8 | 0 | Too long | 3.02 (41) | 0.42 |
| Fun | Not fun | 0 | 0 | 12.2 | 58.5 | 29.3 | Very fun | 4.17 (41) | 0.63 |
| Artwork | Did not like | 2.4 | 7.3 | 22.0 | 41.5 | 26.8 | Like very much | 3.83 (41) | 1.00 |
| Snippets of scientific information [b] | Did not like | 0 | 11.8 | 29.4 | 26.5 | 32.4 | Like very much | 3.79 (34) | 1.04 |
| Desire to play the game in the future [c] | Not likely | 2.4 | 7.3 | 39.0 | 43.9 | 7.3 | Very likely | 3.46 (41) | 0.84 |
| Frequency of future play [c] | None | 2.4 | 34.2 | 46.3 | 14.6 | 2.4 | Very often | 2.80 (41) | 0.81 |
| Expected game playability and engagement for future players without much prior microbiome knowledge | Very poor | 2.4 | 14.6 | 19.5 | 43.9 | 19.5 | Excellent | 3.63 (41) | 1.04 |
| **Experiences/Learning gains** | | | | | | | | | |
| Opinion on the usefulness of microbiome knowledge | Not useful | 2.4 | 17.1 | 26.8 | 31.7 | 22.0 | Very useful | 3.54 (41) | 1.10 |
| Effectiveness in increasing curiosity about microbiomes | Not effective | 9.8 | 19.5 | 34.1 | 34.1 | 2.4 | Very effective | 3.00 (41) | 1.02 |
| *Those with less prior knowledge* [d] | | | | | | | | | |
| Effectiveness in teaching microbiome content | Not effective | 12.0 | 20.0 | 48.0 | 20.0 | 0 | Very effective | 2.76 (25) | 0.93 |
| *Those with more prior knowledge* [d] | | | | | | | | | |
| Effectiveness in reinforcing microbiome content | Not effective | 6.3 | 18.8 | 31.3 | 37.5 | 6.3 | Very effective | 3.19 (16) | 1.05 |
| Effectiveness in connecting microbiome topics | Not effective | 2.4 | 26.8 | 39.0 | 26.8 | 4.9 | Very effective | 3.05 (41) | 0.92 |
| Interest in taking formal classes about microbiomes | Not interested | 14.6 | 24.4 | 24.4 | 31.7 | 4.9 | Very interested | 2.88 (41) | 1.17 |
| Likelihood of behavioural/lifestyle change due to game | Not likely | 48.8 | 17.1 | 22.0 | 12.2 | 0 | Very likely | 1.98 (41) | 1.11 |

[a] Only 38 out of 41 participants rated their responses toward the instructions as these questions were added later on.

[b] 7 participants indicated that they did not read the snippets of scientific information in the cards, values calculated were based on the 34 participants who had read them.

[c] This question was posed in the context of participants owning a personal copy of the game.

[d] Based on participants' self-evaluation of their level of prior knowledge about microbiomes, they were guided to rate either the effectiveness of the game in teaching microbiome content <u>or</u> its effectiveness in reinforcing microbiome content.

## A. Instructions

Participants rated the ease of understanding and the presentation of the instructions near average (2.74±0.98 and 3.11±1.09 respectively). Qualitative feedback on the instructions revealed that many participants felt uncertain of game components, rules and mechanics (19 participants), that phrasing and overall wordiness of the instructions could be improved (14 participants), and that the instructions lacked emphasis on the goals of the game (3 participants). They suggested the need for more examples, visuals or even a demonstration video (10 participants) and reformatting the instructions (3 participants).

## B. Game Accessibility and Player Engagement

Participants agreed that the length of one game was just right (3.02±0.42) and felt that the game was fun (4.17±0.63). They also had a good impression of the artwork (3.83±1.00) and scientific snippets included on the game cards (3.79±1.04), although 7 participants did not manage to read these snippets. Most participants responded positively regarding the replayability of the game, with a likelihood of playing the game if they owned it scoring 3.46±0.84, at an average frequency of 2.80±0.8. They perceived that players without any prior microbiome knowledge would be able to play and find the game engaging (3.63±1.04). Suggestions were given to enhance the game by changing the game mechanics to enrich learning (17 participants), improving the quality of game components (7 participants), including visual aids in the instructions (6 participants), and refining the artwork aesthetics (4 participants).

## C. Experiences and Learning Gains

Gameplay helped participants to recognise the usefulness of microbiome knowledge (3.54±1.10), and to a lesser degree, connect topics (3.05±0.92) and raise curiosity (3.00±1.02). Participants who indicated more prior knowledge reported that the game was moderately effective in reinforcing existing content (3.19±1.05) while those with less prior knowledge indicated that the game was less effective in teaching content (2.76±0.93). In the qualitative feedback, suggestions for improving learning gains involved linking the scientific snippets found on the cards to gameplay (4 participants), and including a quiz component in the game mechanics (3 participants). Participants showed little interest in taking formal microbiome classes after gameplay (2.88±1.17), and only half (51.2%) indicated potential behavioural or lifestyle changes: 14 mentioned changes in their diet, two mentioned an increased curiosity in microbiome-related topics while one reflected on blindly chasing lifestyle/dietary trends.

## D. Key Lessons Learnt by Students from Playing the Game

Drawing on open-ended feedback from participants, the top three ideas drawn from gameplay were the importance of the gut microbiome in health (8 out of 36 responses, 22%), how our microbiome is affected by multiple factors (19.4%), and the importance and definitions of pre/pro/syn-biotics (16.6%).

## IV. DISCUSSION

Based on the feedback received, the game was enjoyable, with the inclusion of both attractive artwork and intriguing scientific snippets being crucial in generating interest. Participants acknowledged the value of the information presented in the game, which could inspire them to further explore specific areas of interest on their own. Participants also agreed that the game's entry barrier was low enough, such that even individuals without a microbiology background could comprehend the gameplay and find it engaging. Positive replayability of the game could aid learning through increased exposure to information on the cards and instructions. Notably, the game's effectiveness in reinforcing existing knowledge received higher ratings compared to its ability to teach new content in this study, aligning with similar findings published by others (Spandler, 2016; Su et al., 2014). While positive, these outcomes need to be viewed with caution as some of the students were likely to have been from classes taught by the researchers. Although feedback was anonymous and collected in the absence of their teachers, we acknowledge that this student-teacher/researcher relationship may have inadvertently introduced bias in this study.

This study also revealed four shortcomings of the game: 1) unclear instructions, 2) ineffectiveness at teaching new content, 3) generating little interest to enrol in microbiology classes and 4) low possibility of changing lifestyles. The latter three points allude to current game mechanics being ineffective in highlighting the relevance of microbiomes to students' lives. To assess the concordance between the game's intended learning objectives and students' actual learning outcomes, self-reported key takeaways were examined. Although many of the mentioned themes corresponded to the learning objectives that were established during the game development phase, it was evident that certain learning objectives were insufficiently emphasised.

With valuable suggestions provided by participants to enhance learning impact, we anticipate that the revised game (version 2), which further integrates learning outcomes with game mechanics, will better showcase the importance and relevance of microbiomes. Furthermore, student insights from the current study have facilitated

the development of assessment tools for quantifying learning gains in future studies through pre- and post-play testing methodologies. Also, since "No Guts No Glory" emphasises the beneficial impact of microbes on our health, future studies could compare the impact of this game to others which emphasise disease-causing pathogens and antimicrobial resistance, especially in how they shape perceptions about microbes.

## V. CONCLUSION

In conclusion, our pilot study of "No Guts No Glory" highlighted its strengths in terms of accessibility and player engagement. However, it also brought to attention areas requiring improvement. These include simplifying the instructions to enhance clarity, ensuring that learning is effectively integrated with gameplay and better aligning game mechanics with the science.

Furthermore, we have identified key learning outcomes from unsupervised gameplay which will guide the development of assessment instruments in future studies, via pre- and post-play testing. Such testing will allow us to evaluate learning gains more effectively in subsequent studies involving both microbiology and non-microbiology undergraduates.

## Notes on Contributors

Chuu Ling Chan was involved in conceptualisation, methodology, project administration and supervision, data analysis and writing (original draft and editing).

Russell Lee was involved in conceptualisation, methodology, project administration and supervision, data analysis and writing (editing).

Lih Ing Goh was involved in methodology, project administration and supervision, data analysis and writing (editing).

Nathanael Hao Kai Chong was involved in project administration and supervision.

Li Neng Lee was involved in conceptualisation, methodology and writing (editing).

Jun-Hong Ch'ng was involved in conceptualisation, methodology, data analysis and writing (editing).

## Ethical Approval

This study was reviewed by the Learning and Analytics Committee on Ethics- Departmental Ethics Review Committee (LACE-DERC) from the National University of Singapore (NUS) Institute for Applied Learning Sciences and Educational Technology (ALSET) and Centre for Development of Teaching & Learning (CDTL), with an exemption from IRB review and the approval to conduct research at NUS (LACE Reference Code: L2021-12-01).

## Declaration of Interest

The authors declare no conflicts of interest.

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