



# Card games as effective tools to enhance bioscience laboratory health and safety education

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## Introduction

Health and safety (H&S) knowledge is critical in a laboratory setting but is often taught passively (Kuzmina and Searle, 2024). Passive learning approaches are associated with lower student engagement and subsequent attainment (Minhas *et al.*, 2012). However, there is a growing body of evidence that active learning tools can improve knowledge retention (Odenweller *et al.*, 1998; Bochennek *et al.*, 2007; Barclay *et al.*, 2011; Freeman *et al.*, 2014). For this reason, higher education institutions are increasingly focused on developing more active learning methodologies, including gamification. Given their ease of implementation, card-based games constitute a highly accessible form of gamified learning (Bochennek *et al.*, 2007) but there is limited evidence of their use within laboratory education.

**Study Aim:** To enhance student engagement and understanding of health and safety information through active, game-based learning.

## Methods: Game design

Three card games based on essential H&S topics were designed:

### 1. Health and Safety Hazard Hunter: A Hazard Symbol Card Game

Identifying and matching Globally Harmonized System (GHS) Hazard symbols with their name, definition and example chemical.

### 2. PPE Lab Gear Up: A Personal Protective Equipment Puzzle Game

Identifying appropriate personal protective equipment (PPE) for various laboratory scenarios and prohibited items

### 3. Lab Equipment Identifier: An Interactive Card Game

Identifying common laboratory equipment and organising them according to their accuracy

## Methods: Pre and Post Surveys

The games were delivered to undergraduate bioscience students as a part of compulsory laboratory health and safety inductions during the first week of term. Student's health and safety knowledge was evaluated using a 10-point scale before and after completion of all three games. Wider pedagogical impact on factors such as student experience, transferable skill development and gamified learning value were also evaluated using open-answer questions or a 5-point Likert scale (Ethics ID: 1035).

## Results: Pedagogical Impact

A total of 146 bioscience and chemical science students participated. Positive feedback was high: **91.1%** found the H&S card games a **valuable addition** to the induction events. Students **liked the design (80.1-92.5%)** and **visual appeal (77.4-86.3%)**, reporting **significant positive impact on learning (82.9%)** and **enjoyment (89.7%)** of key H&S concepts (Fig. 1).

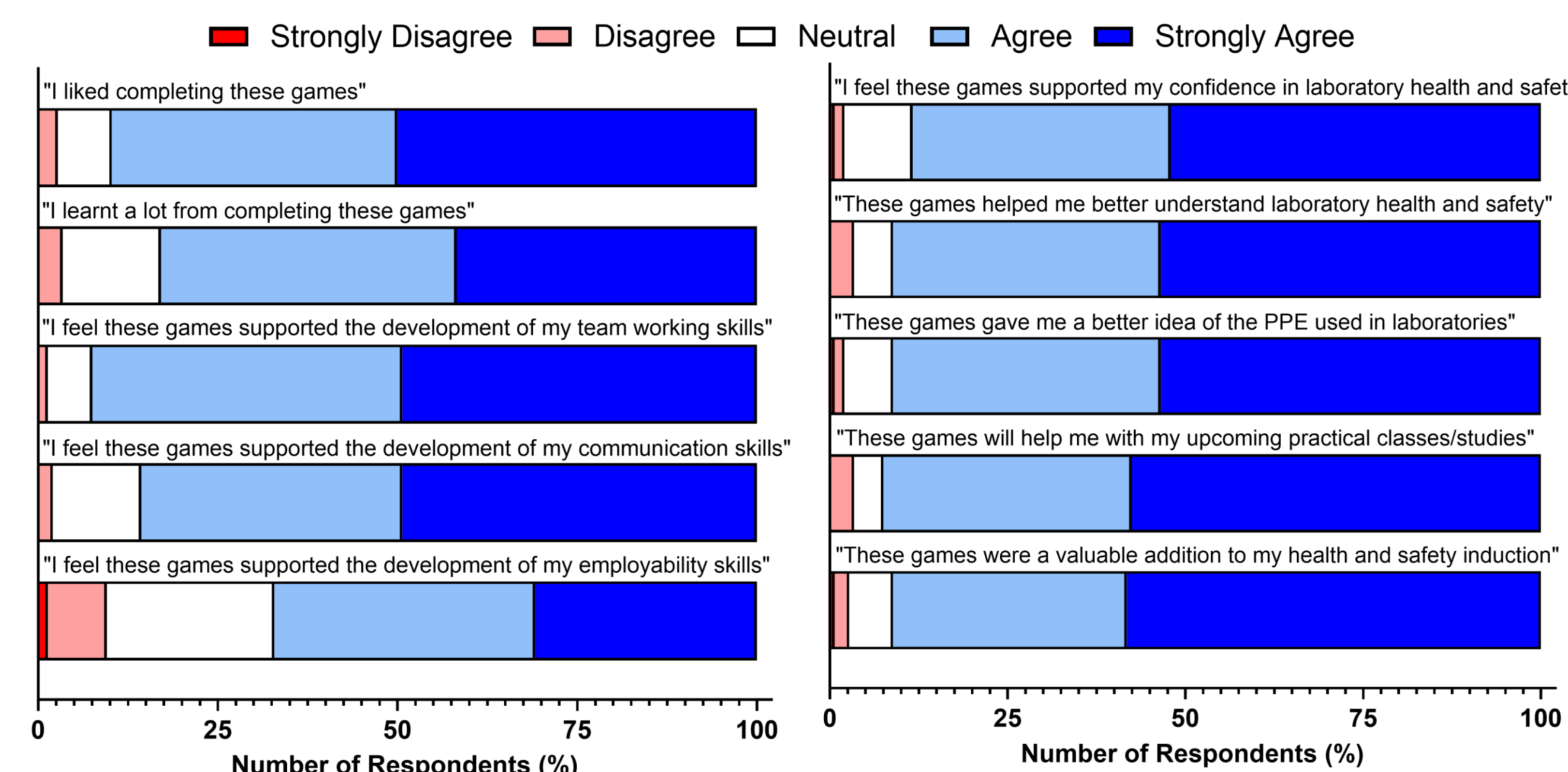


Figure 1. Student's enjoyment and perceived value of the card games. Students rated their enjoyment and perceived value of the games for skill development and their preparedness for futures studies, using a 5-point Likert scale.

Pre & post-evaluation revealed a significant increase in self-perceived knowledge of H&S ( $7.8 \pm 1.5$  to  $8.8 \pm 1.1$ ,  $P < 0.001$ ), PPE ( $8.2 \pm 1.6$  to  $9.1 \pm 1.0$ ,  $P < 0.001$ ), lab hazards ( $7.7 \pm 1.5$  to  $8.8 \pm 1.1$ ,  $P < 0.001$ ) and laboratory equipment ( $7.5 \pm 1.5$  to  $8.9 \pm 1.1$ ,  $P < 0.001$ ).

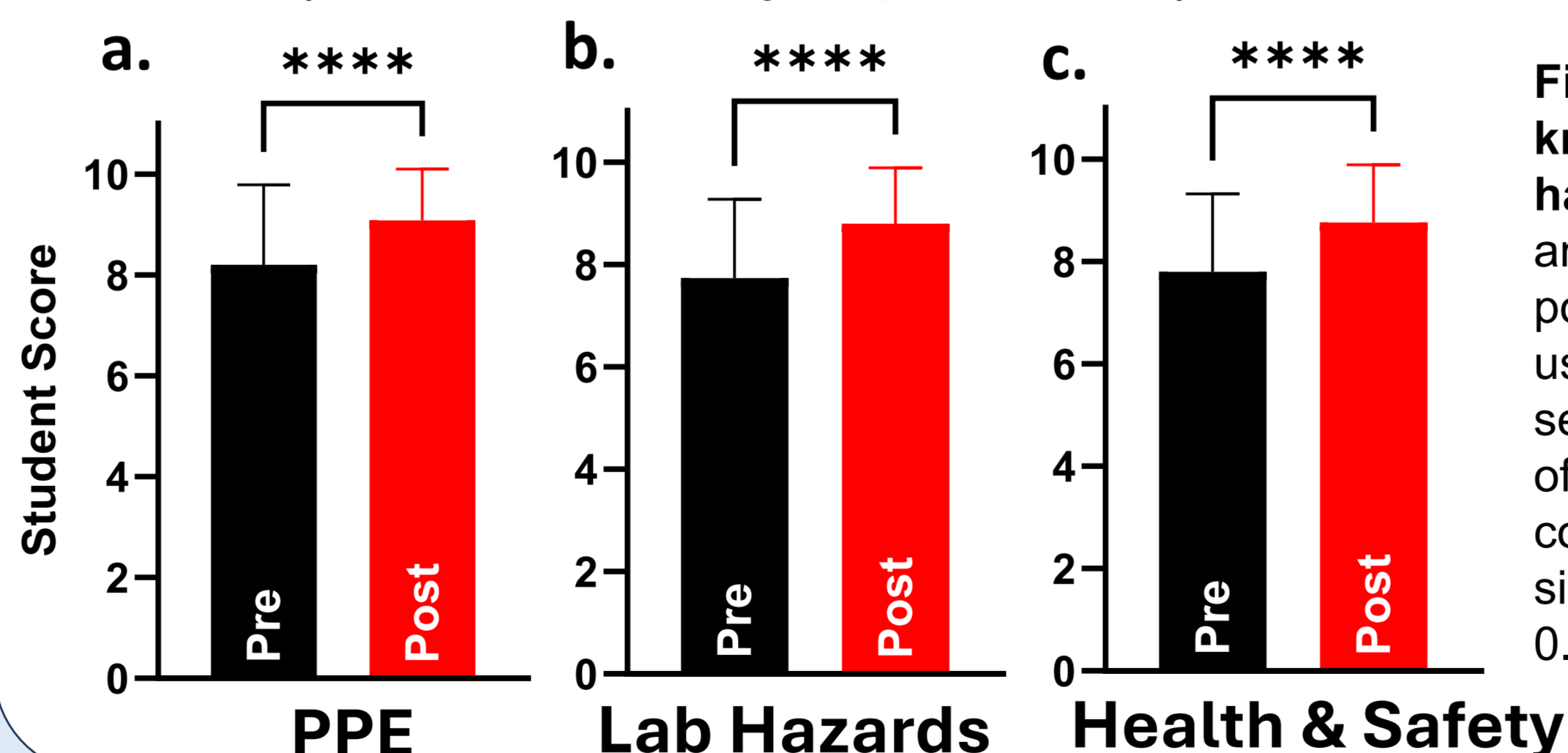


Figure 2. Self-perceived knowledge of PPE, lab hazards and H&S. Pre and post surveys (10-point Likert scale) were used to evaluate students self-perceived knowledge of key health and safety concepts. Asterix indicate significant differences  $P < 0.001$ .

## References:

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**Disclosure statement:** All materials included in the poster represent our own work, any ideas that are not our own have been referenced. The work has not previously been published and is not being considered elsewhere. There are no conflicts of interest that have influenced our findings.

## Results: Equitable Student Experience

Students' enjoyment, learning and self-perceived knowledge from the games was not impacted by their entry qualification (Fig. 5a), socioeconomic status (Fig. 5b) or minority status (Fig. 5c)

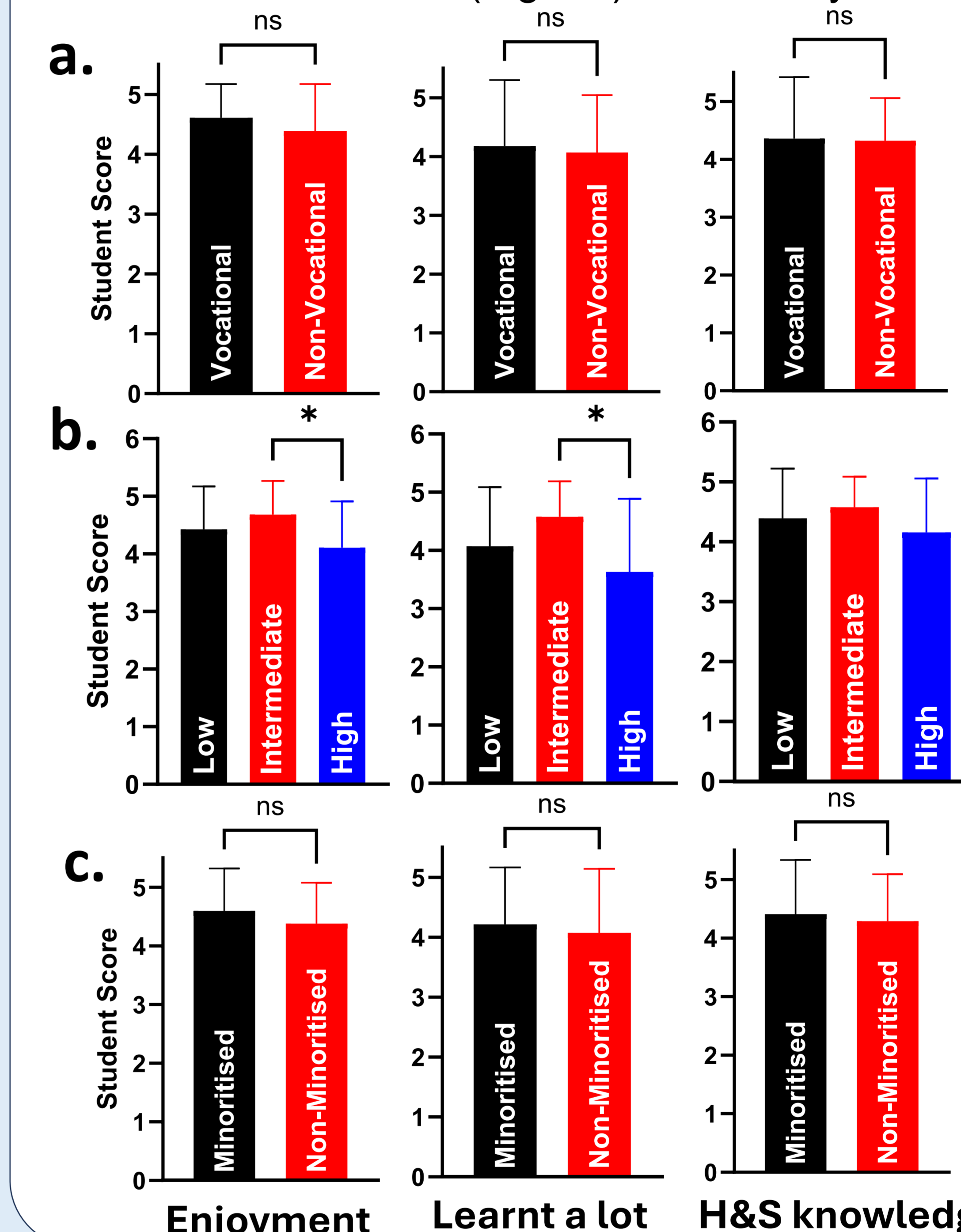


Figure 3. Student enjoyment, learning perceptions and H&S knowledge stratified according to: Entry Level Qualifications (a), Socioeconomic Status (b) and Minority Status (c). Participant responses were stratified via entry level qualifications, socioeconomic according to TUNDRA and POLAR 4 and minority status to evaluate the equity of student game experience

## Conclusion

These findings highlight the wide benefits of card games to enhance health and safety education whilst providing a positive and equitable student experience during the induction period.