

## Keywords

ELISA, Immunology, Simulation, Pedagogy, Co-creation.

## Introduction

The Enzyme-Linked Immunosorbent Assay (ELISA) is a fundamental technique in immunology used to detect biological molecules such as antibodies and antigens. It is widely used in the diagnosis of HIV, pregnancy detection, microbiological assays, and therapeutic drug monitoring [1] [2].

However, it is often perceived as a complex procedure for Biomedical students who have limited experience with the laboratory.

To address this gap and enhance practical comprehension, third-year undergraduate Biomedical Science students at the University of Lincoln developed a comprehensive, student-led ELISA skills protocol. This initiative aims to develop experimental skills and enable students to effectively perform an ELISA by deconstructing the fundamental components of the technique through interactive workshop sessions.

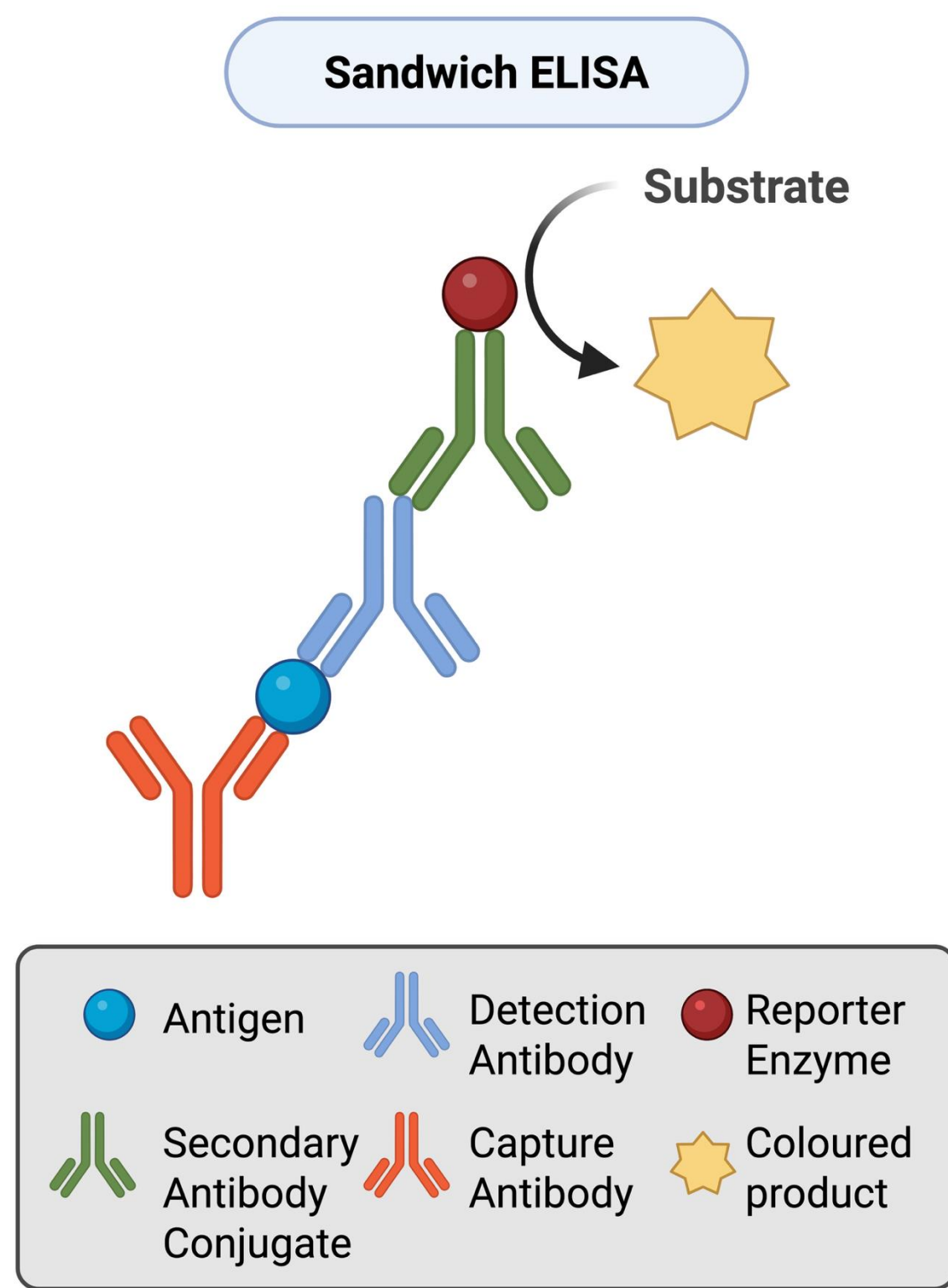


Figure 1. Sandwich ELISA [4].

## Methods

### Session Protocol and Structure

The student-led, collaborative project taught practical ELISA-based skills. This protocol focused on the application of fundamental key skills of an ELISA, concluding with the utilisation of a Bio-Rad ELISA Explore Kit [3] (Figure 2). Each activity included questions to reinforce proper technique and comprehension of knowledge, preparing students for independent execution.

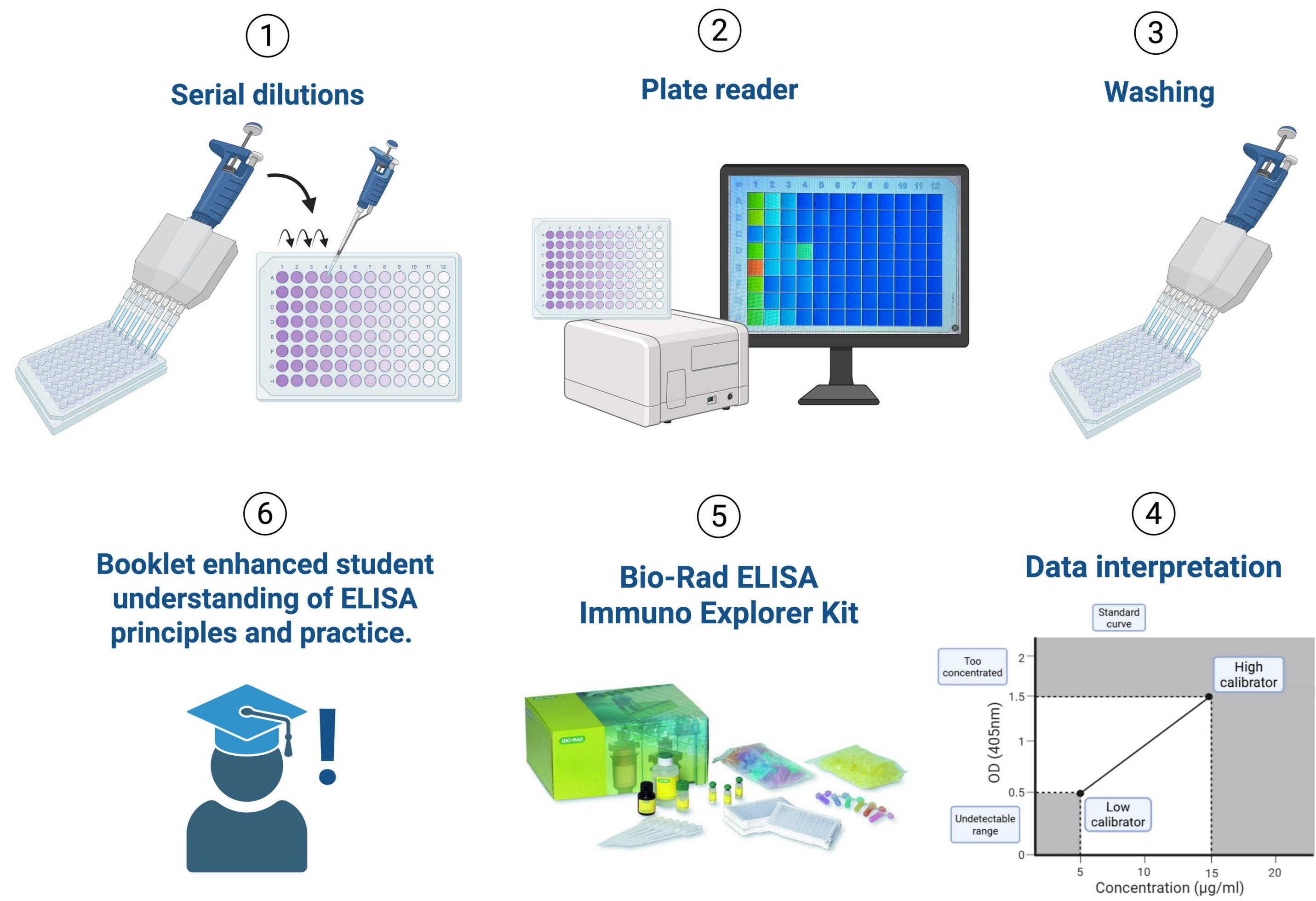


Figure 2. Structure of ELISA protocol and education impact [4].

### Student feedback

Ethical approval was granted by the School of Natural Sciences Ethical Committee.

Students who had participated in completing the workshop sessions were asked to complete a feedback questionnaire to assess their experience of the ELISA workshops.

The questionnaire included both qualitative (free-form text responses) and quantitative (fixed-option responses) questions.

A 7-point Likert scale was utilised to assess students' engagement and satisfaction with various aspects of the sessions (Figure 4). Open-ended questions were also included to capture detailed feedback and suggestions for future improvements (Figure 3).

The rating scale was coded as follows:

- 1 = Strongly disagree • 2 = Slightly disagree • 3 = Disagree • 4 = Neutral
- 5 = Agree • 6 = Slightly agree • 7 = Strongly agree

## Results

### STUDENT COMMENTS



Figure 3. Participant quotes from feedback questionnaire [4].

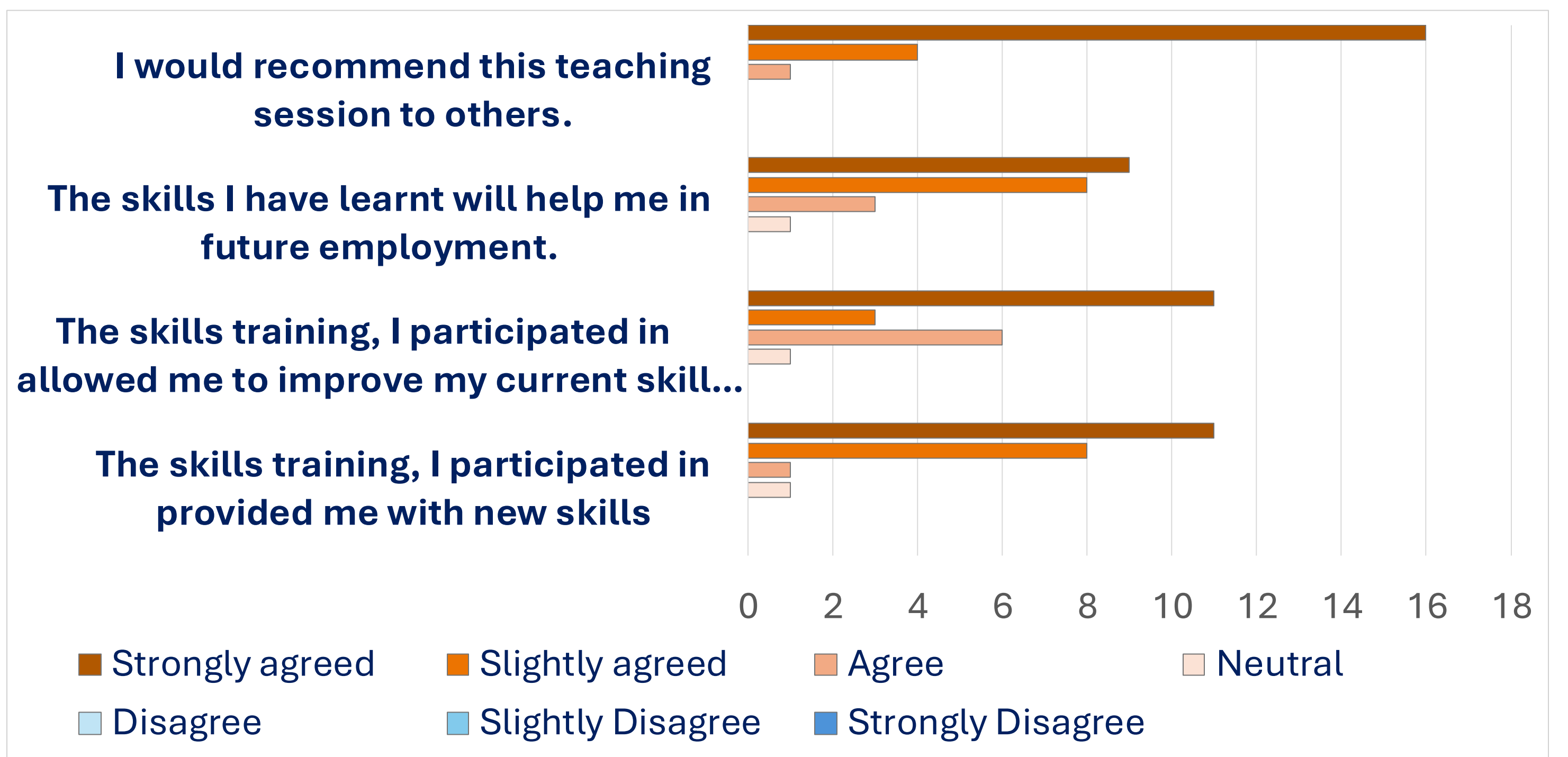


Figure 4. Likert scale for each question by students [4].

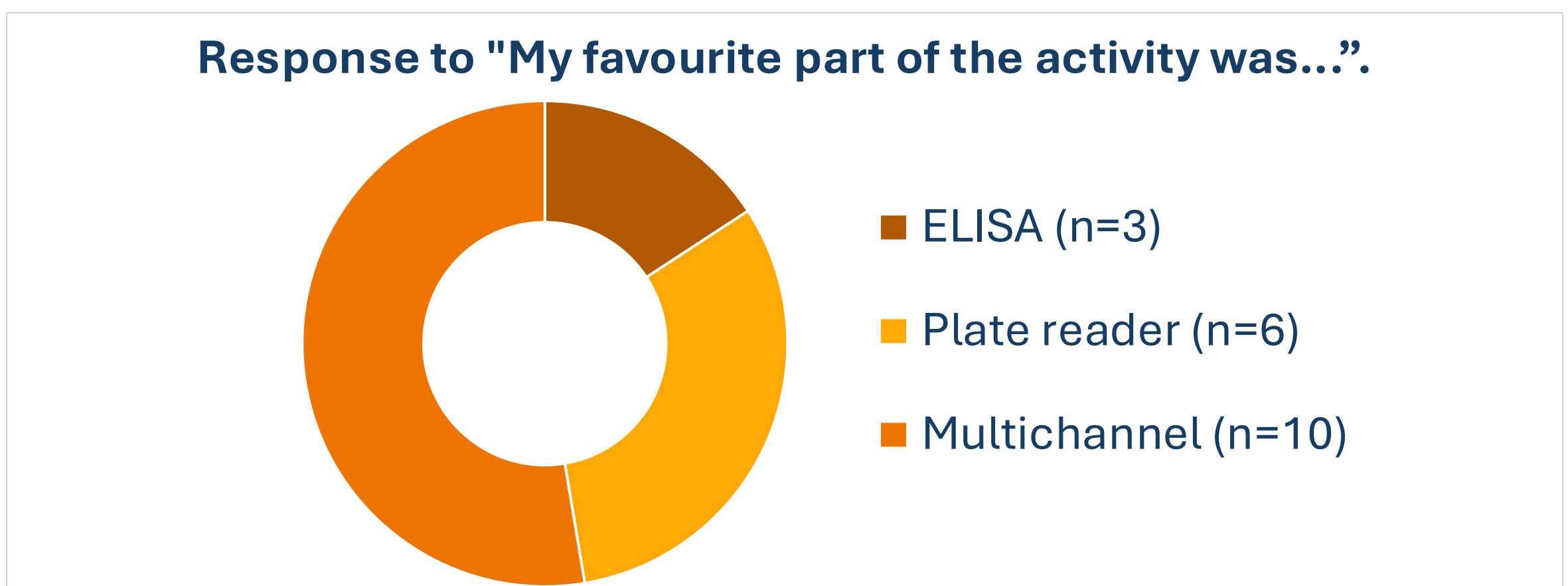


Figure 5. Participants response to their favourite part of the activity. N=19 [4].

## Discussion

A total of 21 students completed the questionnaire, with the responses indicating a highly positive and effective learning experience. Evaluation showed that all students (100%, n = 21) recommended the session, and 95.2% (n = 20) gained new skills, highlighting the session's effectiveness in developing practical competency and a deeper understanding, particularly in conducting an ELISA. Students valued the supportive and safe environment. Future improvements suggested by students included longer sessions and additional demonstrations.

## Conclusion

The ELISA workshop enhanced student education by providing a hands-on laboratory experience, directly addressing the issue of limited exposure to techniques such as ELISA. It demonstrated the success in skill development, showing the value of practical learning experiences. To address the challenge of limited lab exposure, future project iterations include integrating interactive learning into practical sessions. Prioritising hands-on opportunities will be crucial for students' essential skills and confidence for success in a scientific laboratory setting.

## References

- [1] Alhaji M, Zubair M, Farhana A. Enzyme linked immunosorbent assay. StatPearls. 2023.
- [2] Sogawa R, Saita T, Yamamoto Y, Kimura S, Narisawa Y, Kimura S, Shin M. Development of a competitive enzyme-linked immunosorbent assay for therapeutic drug monitoring of afatinib. Journal of Pharmaceutical Analysis. 2019 Feb 1;9(1):49-54.
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- [4] Figures and images created with Biorender.com

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