Using Smart Worksheets Formatively to Improve Educational Outcomes
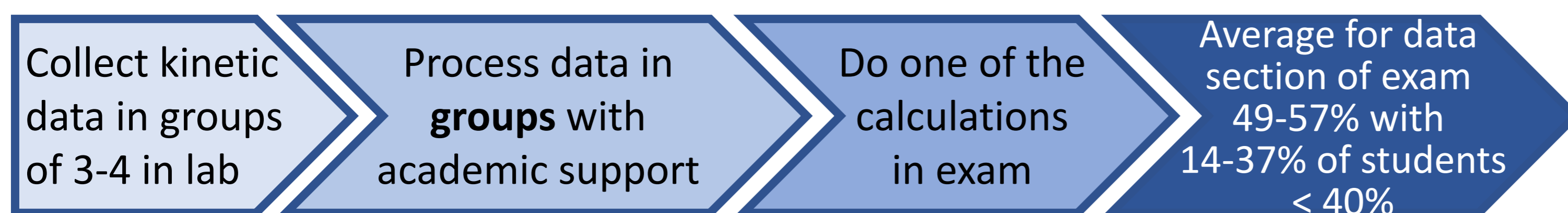
Dr Alison Hill, Department of Biosciences, University of Exeter, Stocker Road, Exeter. EX4 4QD. a.m.hill@ex.ac.uk
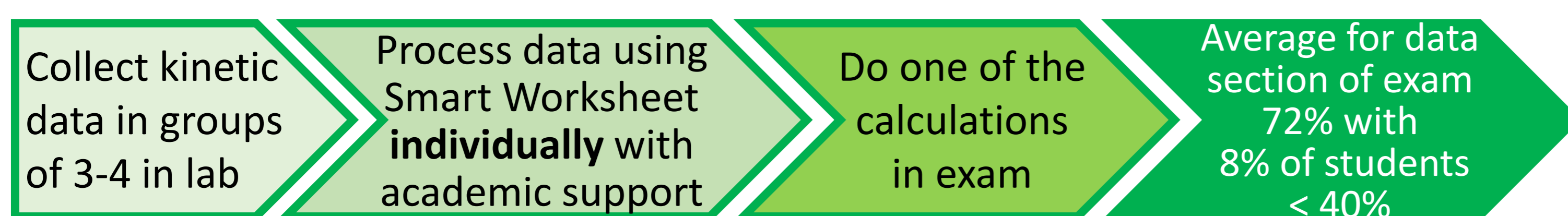
Introduction

I am module lead for a second year Analytical Techniques for Biochemistry which is taken by students from a variety of degree programmes including Chemistry, Biochemistry, Biology, and Medical Sciences. As part of this module, they are required to collect kinetic data in the laboratory in small groups. In the end of module exam, students must complete one of the three calculations for 40% of their exam mark.

Collect kinetic data in groups of 3-4 in lab → Process data in **groups** with academic support → Do one of the calculations in exam → Average for data section of exam 49-57% with 14-37% of students < 40%

Performance on the exam was linked to post-16 maths qualifications (which is not an entry requirement for these degree programmes).

Addressing the Maths gap

In 2019 I developed a Smart Worksheet with Learning Science[1] to improve competency and confidence in carrying out these calculations. The Smart Worksheet integrates seamlessly into the online classroom and was used formatively.

Collect kinetic data in groups of 3-4 in lab → Process data using Smart Worksheet **individually** with academic support → Do one of the calculations in exam → Average for data section of exam 72% with 8% of students < 40%

Student performance on the quantitative section of the exam increased significantly ($p < 2 \times 10^{-11}$, Kruskal-Wallis test).

Student Feedback: overwhelmingly positive

I did not do A-level maths before my degree which meant the thought of a whole exam question on the topic was completely daunting. Yet, the interactive worksheet guided me through the stages to understand the calculations in greater depth. I also used the tool in my revision for the module with the provided class data. This allowed me to consistently test my understanding to the point where this first exam question was my highest scoring section of the entire paper! I think it should definitely be applied to other modules to battle the maths confidence barrier that a lot of students face.

'It made me a lot less stressed with respect to the January exam which meant I was able to concentrate more on the rest of the content.'
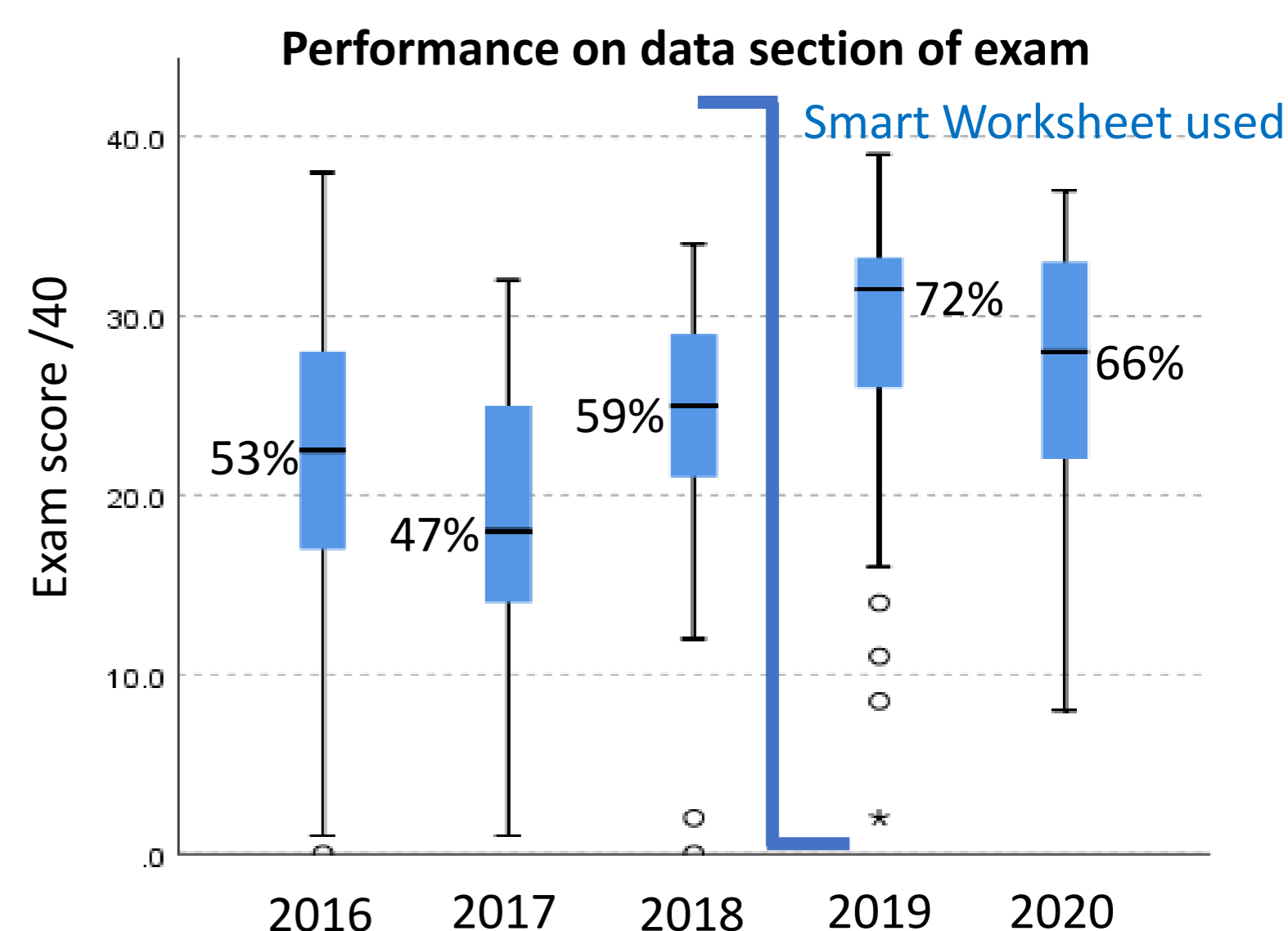
'It massively helped me carry out the calculations. Without the work sheet I would be very confused as I would not know if my maths was correct.'

'It guided me through the calculation steps which made the whole process seem a lot less daunting.'

Second Iteration

I wanted to know whether the increase in student performance observed was due to an increased understanding in how to perform the calculations, or whether it resulted from rote learning the individual steps and quantities (eg time, volume)?[2]

To test this hypothesis, in the 2020 exam, I changed the values of some of the parameters. Very few students 'fell into the trap' and the average for the exam paper and module was identical despite a moderate drop in performance on the quantitative question. While we still had some fails in the exam, the students 'failed better'.

Performance on data section of exam

Smart Worksheet used

Exam score /40

53% | 47% | 59% | 72% | 66%

2016 | 2017 | 2018 | 2019 | 2020

Concluding remarks

- The Smart Worksheet is a game changer. We can see at an instant who can and who cannot do the calculations. Every student uses their own data and cannot 'hide' behind others in their group.

- Use of a Smart Worksheet formatively has resulted in a significant learning gain for our students and broken the link between module performance and post-16 maths qualifications.

- Highest benefit has been seen in the students with lower entry Tariffs; we have significantly reduced the number of fails for both the exam and module.

Looking Forward

In a post-Covid 19 environment, we will continue to use the Smart Worksheet with historical data so that students can get experience in data processing. Support will be provided on-line rather than in person.

References

1. https://learningscience.co.uk/post-labs
2. J.-M. G. Rodriguez, K. Bain, N. P. Hux, and M. H. Towns, *Chem. Ed. Res. Prac.*, **2019**, *20*, 175.