Teaching Biomedical Engineering undergraduates how to keep a lab notebook

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Introduction

Keeping a lab book is a key skill for biomedical engineers, but teaching on this is often inadequate[1], with students reaching postgraduate level with out understanding how or why they should keep a lab book

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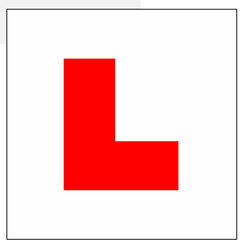
We give them written instructions and examples at the start of their first lab module, but knowing what and how much to include in your lab book is as much art as science, and only comes with experience… a process which can be speeded up by provision of feedback….

We have tried giving extensive personal feedback, and like others, have found this very time consuming[2], and unsustainable, particular with an increasing cohort size.

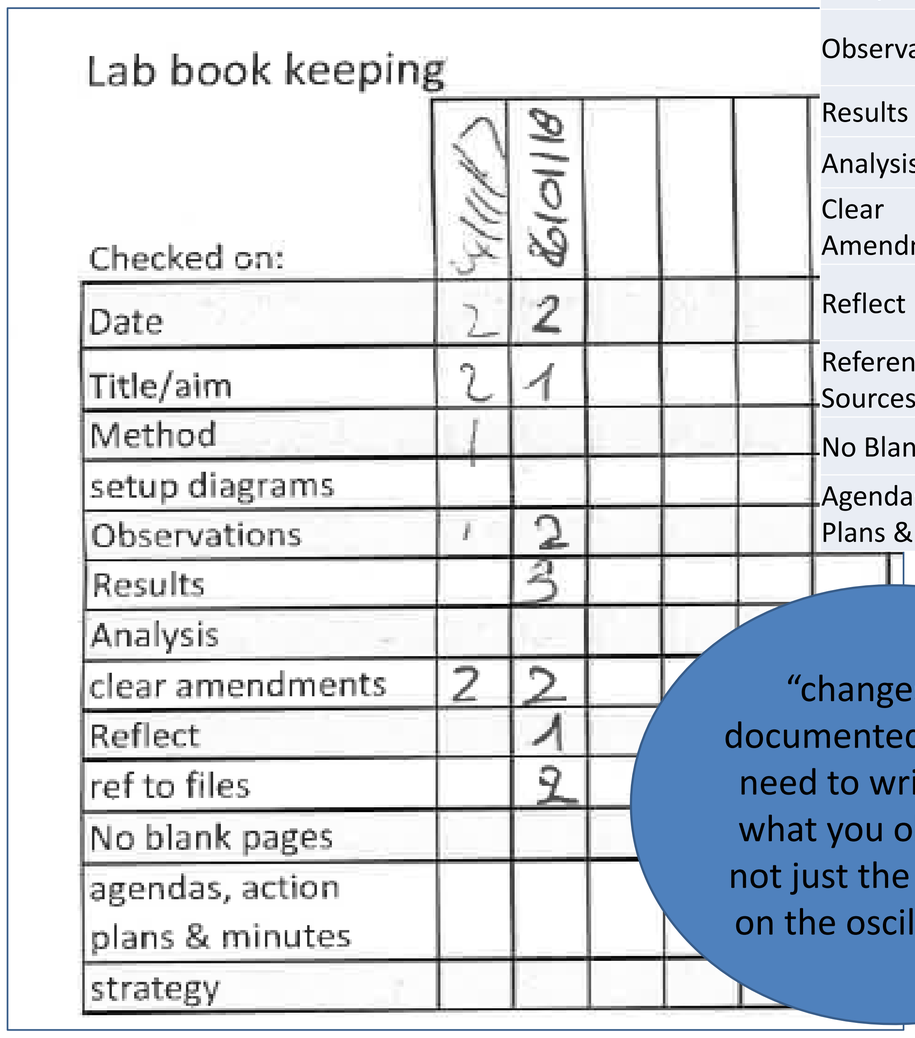
This year we trialled a method inspired by a driving instructor's competency chart; combining aspects of rubric and 'live marking'[3].



Methods

Key aspects of good lab notebook keeping were identified by the authors, in consultation with colleagues.

Date	All entries in lab book should be dated. As well as helping navigation this helps prove who did what when, which can be important in e.g. patent disputes
Title/aim	Helps you find the right section when flicking back through
Strategy/Action plan	Before the detailed methods, give an overview of what you will do, explaining clearly WHY you will do it, what questions it answers
Method	Relevant information in sufficient detail for someone with your training to repeat the experiment. However it should refer to standard instructions (including lab work sheets) rather than repeating details which can easily be looked up.
Setup Diagrams	How equipment was laid out/circuit diagrams etc. As with method, reference other sources where appropriate.
Observations	What did you notice whilst setting up and conducting the experiment/research? Any abnormal waveforms/sounds/heat etc.? How accurately could you place things? These details may not appear significant at the time, but you realise they are vital later.
Results	Tables, descriptions, data and/or filenames with location of electronic copy (if so include description/main features in lab book)
Analysis	These may be numeric or qualitative, written in the book or in an electronic file it references to.
Clear Amendments	Mistakes and corrections should be crossed through with a single line, so the original text can still be read. It is good practice to add a comment (e.g. "realised component 'x' in wrong place, so data invalid"). It best practice to date and initial this amendments.
Reflect	Not a formal discussion, but at the end of each activity, it is good to reflect on what you have learnt - both with respect to the stated aim, unexpected extras and how to do experiments /project work
Reference Sources	See Method, Observations and Results. Include enough information to locate the source (many need to include which computer/network drive), and a brief summary of the content.
No Blank Pages	Reduces possibility of accusations of tampering (see Date). If blank space is left by mistake or deliberately, place a single line through it.
Agendas, Action Plans & Minutes	Project management , applicable mainly to projects and group work, including scenarios. Recording key points from team and supervisory meetings is important, useful collective memory and record of agreements.



"changes well documented, but you need to write down what you observed, not just the numbers on the oscilloscope"

Student were given an A4 sheet to stick at the front of their lab book

Each lab session:

- 2-3 topics selected
- Facilitator inspected lab notebooks, making brief verbal comments, relating to the topics
- scoring that element:
  - 0 (unsatisfactory)
  - …
  - 3 (best practice)

Results & Discussion

Students responded well to the lab grids. Productive conversations were had during the live marking and students engaged more with the verbal feedback than they had with written comments. **Staff** load was much less than offline marking of lab books (5 minutes per student vs 1h per lab book for offline marking).

Whilst it proved **difficult** for a facilitator to get round all the students (~20) in one session, it was **easy** to spot which students were not improving and focus more time on them, allowing them to make immediate changes, and to provide additional feedback in subsequent weeks, and subsequent modules.

References

1. Stanley JT, Lewandowski HJ. *Physical Review Physics Education Research*, 2016; 12.
2. Fernandez M *et al.* 7th International Technology, Education and Development Conference (INTED2013). INTED Proceedings, Valencia, SPAIN; 2013:231-238.
3. Hance J et al. European Journal of Cardio-Thoracic Surgery, 2005; 28: 157-162

Future work

Lab notebooks will be collected from each year group and the quality of lab book records systematically compared for work completed before and after the introduction of the grid.

Conclusion

Observations show that the method enabled constructive feedback to be given in a more frequent and timely manner. Thus it was better used by the students, yet the process took less staff time. This method shows much more promise than other approaches tried. It will be used again, with minor refinements, next year.