Workshop on

Efficient and effective teaching and assessment with MATLAB

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Abstract: The proposed workshop is based on the seminar within the 2012 HEA seminar series http://www.shef.ac.uk/acse/events/heaseminar2011. The intention is to share good practice with delegates in the learning and assessment of MATLAB within the engineering curriculum. The workshop will focus on three main themes:

1. Helping students engage with learning MATLAB and supporting independent learning.
2. Efficient assessment and feedback of MATLAB assignments.
3. Creative uses of MATLAB for final assessments.

Each theme will be presented and discussed briefly from the front, including reflections from both the staff and student perspectives. There will then be time for delegates to try out the associated resources and techniques and thus evaluate for themselves their likely efficacy in different scenarios. There will also be time for delegates to engage in dialogue and share ideas with each other on other aspects of teaching and learning with MATLAB.

Delegates should bring earphones if possible that can be used on standard workstations, although the organisers will bring a number of spare sets.

Introduction and background to workshop

Due to its prevalence in industry, cost and wide ranging functionality, MATLAB has become a de facto standard in the engineering curricula of many Universities. While it does not replace other programming languages entirely, it is commonly used for supporting problem solving of many engineering scenarios, especially where the numerical computations required would otherwise be tedious or unmanageable. The flexible interface, short cuts and numerous toolboxes mean that students can focus on the problem they wish to solve or illustrate rather than the creation of complex code.

Student engagement with and learning of MATLAB

Nevertheless, students still need to gain confidence in MATLAB basics and some simple programming constructs such as function files, conditionals and loops in order to use the environment effectively and for many students there is fear factor as they associate MATLAB with programming and this affects their ability to progress quickly enough. Indeed, there is a lot of historical anecdotal evidence in the author's department that students have failed to engage properly and enter their third year where
the software is needed for project work and are clearly unable to sort out even basic queries by themselves (Rossiter and Gray 2010).

It is well reported in the literature that undergraduates can struggle with programming. In the author’s experience, these struggles are replicated in student usage of MATLAB, because the basic skill requirement for most problem solving involves some level of programming and thus familiarity with concepts such as files, variable names, functions, inputs and outputs, loops, conditionals, etc. Historical data in the author’s department suggested that even with a lot of support in terms of materials and laboratories, students found MATLAB difficult and, of more concern, did not like it!

This workshop will present one solution to tackle the issue of student disengagement and disillusionment which has given a marked change in student perceptions and engagement, as well as reinforcing the development of student independent learning skills. Some the associated student evaluation will also be presented. Moreover, delegates will have the opportunities to experience firsthand the proposed teaching technique and tools and thus evaluate for themselves what this feels like and thus compare to more conventional workbook or lecture style resources.

**Novel uses of MATLAB to support student engagement and learning of a generic engineering curriculum**

The prime focus of this workshop is students becoming competent users of MATLAB and students use of MATLAB as a tool within engineering problem solving. However, a parallel usage is MATLAB as a tool for staff to demonstrate and illustrate engineering topics and thus help bring those topics to life for students. In essence, MATLAB can help student engagement with many topics.

There will be a brief part of this workshop which demonstrates some MATLAB GUIs developed by the author for supporting the learning of modelling, analysis and control topics or helping students understand behaviours. Once again, delegates will have the opportunity to use these GUIs as well as explore for themselves the workload implied in developing these.

As an aside, the first author has found that using GUIs within student assessments of MATLAB has been an effective way of firing student enthusiasm and engagement with MATLAB. Many students go far beyond the assignment requirements and therefore are implicitly gaining deep understanding of how to code in MATLAB.

**Assessment MATLAB development and providing feedback**

With large classes, marking and provision of feedback can be enormously time consuming. However, recent work has demonstrated that for what can be considered quite complex MATLAB assignments, it is possible to automate the generation of both marks and feedback, thus enabling students to be more autonomous learners, but also reducing the long term marking load of staff. The workshop will discuss the mechanisms required to achieve automated marking, along with the pros and cons and some advice on the type of assignment where this is well suited. This will be backed up by both staff and student reflections on the process.

Delegates will have the opportunity to experiment with using the automated marking code, both from the staff and student perspectives and thus make their own judgements on potential efficacy.

**Using MATLAB in final assessments and examinations**

The final main theme considers the use of MATLAB during final assessment, for example the main or even only exam for a module. For some topics, numerical requirements severely limit the type of question that can be asked in standard paper and pen form, and can make examinations predictable. By allowing students access to MATLAB, it opens up the range of possible questions to give a far more authentic scenario as well as assessing students with a more authentic mechanism. Several examples of academics who have utilised this will be presented and evaluated.
Concluding remarks and Session learning outcomes

By the end of the workshop attendees will have been exposed to some good practice in the teaching and assessment of MATLAB which has proven efficacy at other UK institutions. They will have had an overview of the pedagogical concepts underpinning the proposals as well as received detailed insight into the issues that may arise, from staff workload, effective and ineffective scenarios and student perceptions. Finally delegates will have had the opportunity to try out the associated resources and techniques as well as share other ideas with each other.

The main techniques and resources attendees will become familiar with are:

1. Techniques and resources for helping students engage with learning MATLAB and supporting the development of independent learning skills. Delegates can take these resources away.
2. Examples of how to use MATLAB for automated marking and feedback generation of student MATLAB assignments. Some discussion of alternative efficient models.
3. Examples of how MATLAB is being deployed to make final assessments more interesting and challenging and discussion of the associated issues.

Workshop structure

After a very brief introduction, the workshop will be divided into approximately 4 parts. Each part will have some presentation followed by time for delegates to practise.

25 min Engagement and independent learning
25 min Automated marking and feedback
20 min Using MATLAB for final assessments
15 min Delegate sharing

Activity 1: Engagement and independent learning (25min)

The presenter will use about 10 minutes to share the findings of the paper Rossiter and Gray 2010 along with more recent staff reflections and student evaluations. He will show how the resources are used to promote independent learning within the students and thus to improve their engagement with and learning of MATLAB. He will also present more recent work on using MATLAB GUIs to improve student engagement with more general engineering topics, as well as tool to enthuse students into deeper engagement with MATLAB itself.

Delegates will then get around 15 minutes to look through the associated resources and place themselves in the position of a student and thus discern whether this technique would work for them. Some example ‘tasks’ will be provided to guide delegates and thus ensure this time is used effectively. Some of the GUIs developed by the presenter will also be available for staff to try out. Delegates should bring earphones if possible.

All the resources would be available for staff to copy and take away.

Activity 2: Automated marking and feedback (25 mins)

One of the biggest obstacles to providing good feedback is staff time. However, in the case of coding assignments where code is developed to solve a particular problem, it is often possible that the efficacy of code can be checked by very mechanistic tests. This is because where code is written as a function file with specified inputs and outputs, there is a unique correspondence between inputs and the correct outputs which thus can be tested automatically. Delegates will be shown a worked example of an assignment and how ‘testing’ of this unique mapping can be tested with automated marking code. Moreover, it will be shown how the code can use multiple inputs to test student code for different strengths and weaknesses and thus provide detailed automated feedback on the code. A file is also available to give tests for collusion between different student submissions. Finally, it is shown how the compilation of marks for each student, and indeed the whole class, can also be automated.
A brief time will be spent discussing the pros and cons of such an approach with specific focus on issues such as: does it really save staff time and what do the students think? What are the alternatives? What are the mechanics of setting this up?

Delegates will then have an opportunity to test the marking code and even to generate their own marking code for a very simple example, and thus to consider the potential applications within their own departments.

**Activity 3: Using MATLAB for final assessment (20 mins)**

Two examples, from different institutions, will be given of how use of MATLAB has been embedded into the formal examinations for final year modules. This will include some discussion of the detailed exam questions and from there how the value and richness of assessment can be improved by allowing the use of MATLAB in the exam.

Speakers will also discuss practical issues required for such an assessment, for example requirements on the examination room, possible weaknesses such as limitations on class sizes, collection and marking of scripts.

Delegates would then be invited to discuss in groups how they might modify examinations for their own modules in the light of this workshop.

**Activity 4: Final discussion and sharing (15 mins)**

The final part of the session will be a round up which will enable delegates to discuss openly their reflections on the resources and ideas covered in the workshop. However more importantly, they will be encouraged to share their own experiences, good and bad, and reflections so that they can all learn from each other. Should there be a will, some discussion could be directed towards the most effective way of sharing MATLAB resources in the future and thus whether the concept of a special interest group should be reinvigorated and how it could be operated.

**References**


**Acknowledgements**

Thanks to Alan Irving (recently retired from Liverpool) for supplying his files, reflections and notes on automated marking with MATLAB.

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