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Supporting development of independent learning skills

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Abstract: One of the main challenges for University staff is that students tend to prefer assessments that are very prescriptive because this reduces uncertainty in what is expected of them. The most obvious downside is that many students resist attempts to move away from a lecture based, or teacher-led, approach to a more student centred or student-led approach to learning. This paper focuses on one aspect of that challenge in the authors' department, that is, how do we convince students as they arrive at University of the need to accept independent learning as the long term norm and in particular to practise this immediately in their learning of MATLAB software. The paper suggests a joined-up delivery of the curriculum but focuses more on the use of FLASH lecture resources to help students bridge the gap between lecture-led courses and total autonomy.

1. Introduction

In the authors' department, as in engineering as a whole, there is a recognition that one of the important skills students need on graduating is the ability to learn independently, with confidence (e.g. University of Sheffield Learning, Teaching and Assessment Strategy, 2005-10 and Engineering Council 2010). However, typical modules are very much teacher-led and many students can get through most of their programme, with the exception perhaps of the individual project, largely by learning and reproducing what they have been taught. As part of strategies to tackle this mismatch, The University of Sheffield (UoS) was successful in its bid for a CETL (Centre of Excellence in Teaching and Learning) called CILASS (Centre for inquiry based learning in the Arts and Social Sciences). One of the main aims of this CETL was to develop, disseminate and support best practice in inquiry based learning, initially in a restricted set of departments and latterly across the whole University. However, of most significance is the profile the CETL gave to the issue of independent learning and the support available to help departments recognise (and tackle) where there might be weaknesses in their own programmes.

The authors quickly recognised the links between some of the issues or difficulties with the progress and satisfaction of students in their own department with poor skills or aptitudes for independent learning (Rossiter et al, 2008). Thus an earlier project looked at transition and how to prepare students for the independent learning skills required at University. Nevertheless, although this project was a success to some extent and certainly popular with the students, it tackled only 'intro week' whereas it is now well understood that transition support needs to be ongoing throughout the first year (Yorke and Longden 2007) and perhaps even beyond.

The need for a holistic approach to curriculum design (Rossiter et al 2009, Mc Cartan et al 2009, Cugnasca et al 2007) is now well understood and the authors have promoted a team approach to the curriculum delivery for several years. Consequently, there had been joined-up thinking about learning outcomes and how these map to assessments and assignments throughout the year as well as the integrated development of a broad range of professional and technical skills. Nevertheless, it was clear at the end of June 2009 that despite this, students were still struggling to come to terms with the demands of independent learning and a substantial number of students felt that insufficient (or inappropriate) support was available for some topics/assignments.

Hence, this paper looks primarily at the issue of independent learning for first year engineers, but also with some discussion of second year engineers. First a background section looks at past practice and

some evaluation of the efficacy of that practice. This is then followed by a section discussing the proposals for 2009-10 and finally a section evaluating the new strategy. The paper finishes with reflections on the outcome of the strategy.

2. Earlier strategies for introducing independent learning

Within the authors' department there was a recognition that students would expect some differences to learning and teaching between school and University and the main challenge is to channel that acceptance of change effectively, from arrival (Rossiter et al, 2008). Clearly this policy needs to be reinforced throughout the year. Furthermore, there was a recognition that the types of independent learning required were quite varied, and this variety needed to be recognised in the assignments students were asked to do. The department deals with this issue in a manner that is equivalent to the EASIMAP project (see references), that is, a table is produced (Rossiter et al, 2009) which shows the assignments required, by week and which professional skills these assignments focus on, in addition to the technical skills appropriate to the module within which the assignment sits. Staff have a meeting well before the semester to agree and/or modify this table to ensure a good balance of the most desirable learning outcomes are achieved.

2.1 Successful independent learning assignments

There was an acceptance that in year 1, independent learning needed to be on a small scale so that students could develop their confidence rather than feel overwhelmed. Consequently some typical early assignments were:

- A brief essay (500 words) requiring some independent research.
- The need to prepare (complete a proforma) in advance of laboratories using notes, but in many cases, without explicit links to lecture material.
- A longer essay requiring independent research and including 'novel' technical content.
- A group poster project.
- A 5 minute presentation within tutor group on a technical theme (which required some research).

On the whole, students responded well to these types of assignments and it seems clear that they have good confidence where independent learning implies doing some form of literature search (in the students' case mostly on the web) and writing a report/essay/poster on this. It would not be unsurprising to say that such assignments are common in school and thus student confidence with this is also unsurprising, even though there was a slight increase in requirement due to the demand for technical content for some assignments.

2.2 Less successful independent learning assignments

Within the workplace, independent learning is most critical where new numerical or computing skills are required. Staff may need to learn a new topic such as modelling, identification or filtering, entirely unaided. This learning thus will cover both generic understanding of motivation and summaries of existing ideas as well as the ability to engage and implement the detailed mathematical algorithms that could be associated. An example of acquiring new numerical or computing skills in the workplace might be when staff need to teach themselves a new software language. In the authors' experience, while students seem to be comfortable with the former type of requirement they are much less able and/or willing to cope with the latter.

The authors have tried for several years to give the students a soft-touch introduction to independent learning of technical topics in year 1 through their approach to MATLAB learning and assessment. Students were provided with some notes as well as fortnightly lectures, but largely directed to learn independently by going through set exercises and computer code, supported by regular assessments and weekly laboratories with demonstrator support – in fact more contact time than in most modules. The resources were designed in a methodical fashion so that students who went through them systematically, and in order, would increase their understanding. They could then apply this understanding to problems.

However, although some students thrived, a large group were unable to 'get it' and repeatedly asked for more prescriptive guidance and lectures on what they had to learn to get the marks. In simple terms, they were unable to learn the software package confidently despite being provided with many

more resources, guidance and demonstrator support than would be available to an engineer in the workplace.

Issues of particular concern were:

- Requests to be taught exactly how to solve a problem before being asked to replicate this, or in other words wanting a very prescribed curriculum – you teach and I learn it.
- An inability to test their own code using commonsense checks, or in other words a lack of awareness or expectation that they can validate their own learning.
- An unwillingness to read the material provided carefully and to go through it methodically; rather they wanted to know 'the answer'.
- A lack of confidence or self-belief.

Some student comments below indicate what the 'unhappy' students feel – we should counter this by noting that the majority of students do cope and recognise the benefit by the end of the year. We should also note that many of the comments are actually erroneous, but are included here because they give a picture of student perceptions:

- *Also in lectures, more details or handouts should be given on MATLAB instead of struggling on that individually.*
- *The matlab needs some helpful explaining*
- *On the whole good, but I think I would have benefitted more if Matlab was taught in a more similar fashion to C.* [NOTE: C is currently taught in a slow spoon-feeding fashion, but based on evidence from later years we are not convinced students really understand it properly even though they think they are doing well.]
- *As matter of fact, matlab is a very complex software to our 1st year student. I strongly recommend add more lectures about matlab. So many times we face on assesement word file, and get noooooo idea how to start!*
- *A classmate used to complain:"If we suppose to learn matlab by ourselves, Why should I go so far away from home, and spent so much money on education, so that to 'learn by myself' here?"*
- *I like the fact the fact that during the labs we were able to see our course and what we learned inaction.*
- *I would appreciate if the MATLAB sessions were more and some useful hand outs were given as guidance to the students.*
- *There should be some books about MATLAB. This would make it very convenient for students to get familiarised with different aspects of MATLAB.*
- *I think perhaps a little more help could have been given with MATLAB*
- *I think this module is very good for establishing a stand alone approach to learning whilst improving team work in aspect such as matlab which helped to identify strengths and weaknesses each member of the group had and what they needed to improve on. The matlab was my favourite part of this module it has given me more confidence as a practising engineer that I have the ability to research and construct my own knowledge on topics.*

2.3 Summary of earlier strategies

MATLAB had been chosen as an obvious language for independent learning because of the existence of so many learning resources both by way of books, the MATLAB website and of course the built-in help which is full of demos such as getting started and other guidance. When supplemented with lectures notes, regular assignments and exemplar m-files to direct students' efforts, we felt students should have ample resource and structure to progress well, and yet it is clear that a large enough group of students are struggling with independent learning of software to warrant an even softer introduction. Many students do not have the skills to grasp how to use the learning resources available in a systematic fashion and are uncomfortable with the more open-ended learning outcome of developing general proficiency as opposed to the comfort of being told to memorise a specific algorithm or routine.

3. Supporting independent learning

Enough students were struggling with the independent learning required to justify a re-evaluation of how the MATLAB learning was set up. There was a desire not to concede to student requests for a spoon-feeding type approach, because this would not benefit them in the long term nor would it be

consistent with accreditation requirements or indeed the UoS Learning, Teaching and Assessment Strategy (LTAS). There was a desire to avoid returning to a lecture format as this would not be consistent with the learning being student-led, and yet a recognition that formal lectures make students, especially overseas students, feel more comfortable with what is required of them. The authors felt that a solution somewhere in the middle would be ideal.

3.1 Software solutions, animations and PowerPoint

There is a rapidly growing accessibility to technological solutions that were previously only available to specialists or those with substantial budgets (e.g. Robyler et al 2000, Khan et al 2006). For the context of this paper, the focus is on a piece of software that is readily accessible to almost everyone, even in primary school, and that is Microsoft PowerPoint. This is the most popular software for presentations, probably because it is simple to use and yet has advanced animation and style capabilities which give the user huge flexibility without the need to learn difficult coding. In simple terms, even primary school children are quite proficient at changing styles and introducing animations. A further significant factor is that with just a small amount of extra effort (Porter 2009) one can produce very advanced animations which communicate a message far more clearly than a fixed picture of text.

Within programming, one of the key skills students need to acquire is the logical construction of code, how to put things in the correct order and to think chronologically or algorithmically. The ability of PowerPoint to animate easily gives a synergy with programming requirements that is easy to exploit and thus to produce PowerPoint shows which support the learning of programming.

Of course the final point is that PowerPoint allows the easy incorporation of screen dumps and pictures and thus it is straightforward to illustrate for a student what solutions should look like, or for instance how exactly to interact with the MATLAB window.

3.2 Use of audio recordings in learning

There is an increasing recognition of the power of recorded audio to facilitate learning (Fidler et al 2006, Intons-Peterson et al 1986, Nortcliffe et al 2009). An obvious advantage of audio is the anytime/anywhere aspect, that is, students can access and use these at their own convenience. A second well-documented advantage is that audio triggers parts of the brain that are not triggered by reading text and thus, by providing an alternative input to the brain, can aid understanding and learning. Consequently it seems rather obvious to state that learning resources can be enriched by the inclusion of appropriate audio to support any text or animation within them.

As argued in the previous subsection, the tools for generating (or recording) audio are now far more accessible than previously and thus the time is ripe for academic staff to begin exploring what potential these might offer. Moreover, easy to use and widely available software is also available for editing audio into bite-sized chunks, should this be required.

Finally, it is noted that there also exist simple tools that allow the systematic integration of audio into PowerPoint, thus closing the loop on the generation of resources with both effective visual impact, animation and audio. In the authors' University there is a license for ARTICULATE, which is a plug-and-play piece of software for generating animations with voiceover:

1. Staff write PowerPoint slides with appropriate animations.
2. Staff record into a desk top microphone while running the ARTICULATE plug in to PowerPoint. The process is simple: as you are recording you simple press the 'next animation' button as you wish the next animation to appear, and the software automatically synchronises the recorded voice with the animations. You record one slide at a time.
3. Once the recording is completed, the PowerPoint is exported to a FLASH file that runs on a web browser.

In summary, readers will recognise that the process is simple and relatively quick. If one accepts that the audio quality can be similar to that in a standard lecture, that is not over-rehearsed, then one can record a large number of slides quickly. In fact the major workload is preparing the animations on the slides.

3.3 Resources prepared

Firstly, it is noted that some of these resources are available on an open website [6] for anyone to access and use. Each slide show is supported by a number of MATLAB m-files which students can use as templates and/or exemplars of how to solve given problems.

Animated lecture slides with voiceover were prepared for year 1 students to cover an introduction to MATLAB and the use of MATLAB for solving and illustrating simple engineering problems and basic coding syntax. This include topics such as sketching of functions, inequalities, differentiation and applications (min/max, tangents), solution of ODEs, complex numbers and simulation of time series. Students were introduced to coding syntax for conditionals, loops and functions (routines with inputs and outputs) and commenting files.

For the year 2 students, two slide shows were prepared although students were encouraged to use the year 1 slide shows if necessary to reacquaint themselves with the basic environment. The first slide shows covered an introduction to the control toolbox and its syntax, whereas the second focussed more on the use of the toolbox for detailed analysis.

4 Student evaluation of independent learning and of the FLASH resources via the web

This section summarises student perceptions of the two main factors discussed in this paper. Firstly are students happy with independent learning, and secondly has the creation and use of FLASH animations helped the acceptance of independent learning and improved student attitudes towards MATLAB?

4.1. Evaluation of year 1 students

Nearly the entire first year cohort (about 60 students present) took part in the evaluation (December 2009) as it was done immediately prior to an assessment. Thus the comments and percentages are a valid representation of student perceptions.

A first point to note is that 88% of the students felt the resources for the module including MATLAB were good or very good. 76% felt the module was well presented and 90% were happy with the year as a whole. This is good evidence that overall the curriculum is well put together and delivered.

- 63% said: I think this was a good way to help students learn MATLAB in their own time and they were easy to use. A further 22% agreed with the above although wanted improvements.
- 53% felt the MATLAB delivery with FLASH lectures had helped them improve their independent learning skills substantially and all but one or the remaining students felt it had helped them a little.
- 98% of the students agreed that the development of independent learning skills was important and the department should require this for some topics, and that the overall balance was good.
- The class was split 53:46 in terms of whether the independent learning requirements of MATLAB were about right or too much. This is interesting because it is not so consistent with other modules where around 90% of students felt the independent learning requirements were about right (in those cases the assignments were probably closer to the research type work they will have encountered at school).

<u>Some student comments on independent learning</u>

1. *It is very important for students.*
2. *It is necessary*
3. *I agree that independent learning is important.*
4. *Good way to prep for career although there is a lot of it and it does pile up fast.*
5. *I feel I have increased the amount of independent learning I have done since I came to university.*
6. *I wish can have more tutorial lecture.*
7. *I liked some of it mainly the dynamics, with the MATLAB I would have preferred a more direct teaching method for the first semester and maybe concentrate on the independent learning later on in the year.*
8. *I think when we first start a course there should be a compromise. The step between college and starting is too big.*
9. *Each lecturer should emphasize the importance and neccessity of independent learning, in the 1st semester (not all lecturers did for us, just some).*
10. *The approach of independent learning for matlab is just about right and the lectures given is interesting.*

Some student comments on use of FLASH lectures for learning MATLAB

1. *I think that the animated lectures were very helpful for independent learning of MATLAB. This approach would be helpful for students to increase their understanding of other modules if the approach were to be adopted universally.*
2. *I think the matlab lectures were very helpful however I would have liked at least one lecture a week with Dr.Rossiter.*
3. *Was very nice and I think more powerpoint slides that are in the format like the ones of matlab should be added for other modules too.*
4. *The lectures on boothwood are VERY useful- thank you.*
5. *The lectures on Boothwood was helpful. However, I think that matlab would be much more easier to learn if there were more lectures in the beginning of the course showing how matlab works.*
6. *The online resources were very good but i think matlab needs to be less independent*
7. *Enjoyed studying matlab, although very challenging for me I found the outcome of the hard work I put in paid dividends.*
8. *It has perfect electronic resources. However, sometimes it is enough to get a slightly different question then you were taught and even if you know what to do, you don't know how to tell it to computer.*
9. *The electronic slides by Dr. Rossiter are really helpful--> self study was possible by using them.*

4.2 Evaluation of year 2 students

The year 2 students had an in-class quiz, using an electronic response system, towards the end of term and a brief questionnaire was tacked onto the end. Thus these percentages represent the whole class which was present (around 100 students). A few also gave written comments before leaving.

80% of the 2nd years felt this was a good way to learn MATLAB in preparation for their assignment. Of the remaining students, 10% already knew MATLAB so did not need them and 5% had not yet started!

It was also interesting that the majority of students were positive about the need to engage with MATLAB which contrasts with earlier years where a substantial minority were inclined to complain. One presumes they felt better able to learn the software this year with the new resources.

Having said that, much as in year one, the students were divided 53:44 in their views on the amount of independent learning required for MATLAB being about right or too much.

The average mark for the associated assignment was about 10% up on previous years.

Student comments

1. *I find them easy to use and informative. My own independent attempts at learning MATLAB would probably have taken much longer without these.*
2. *Good but would prefer some taught sessions.*
3. *They were very helpful.*
4. *The material available for learning MATLAB is really good and improvement on the previous year.*
5. *Really good, should be expanded to cover more of this module.*
6. *The animated MATLAB lectures should include a run through of worked examples.*

4.3 Summary

There is still some divergence of opinion. which could be due in part to the wide range of intake (around 50% overseas) and abilities, but there is clear evidence that the adoption of FLASH lectures has been well received by the majority of students and has helped them engage with topics independently where before they may have complained more or struggled more. There is also strong evidence that the first year students have been convinced by the joined-up approach to independent learning and are responding well to its demands. Nevertheless it is interesting that a sizeable group would still like the first few weeks of MATLAB to be delivered in a more spoon-feeding type fashion; the authors are less convinced that this would make a major difference and would simple delay the point where students need to start thinking for themselves by which point they may have a false confidence in their understanding which is a barrier to further progress with the software. There are also the practical challenges of getting large classes into a single PC laboratory, and prior experience was that the noise levels due to the computers and poor layouts made effective delivery from the front difficult.

5. Conclusion

The authors have trialled an alternative model for introducing MATLAB as part of a joined-up approach to encouraging student development of independent learning skills. In essence some 'lecture' type material (animated PowerPoint with a voiceover) is now provided via the web so that students can go through this in their own time and/or during laboratory sessions with demonstrators available.

Student evaluations have shown two major findings. Firstly, the joined-up approach to independent learning is proving effective, and the majority of students have accepted this, albeit this is more demanding than lecture-led material. Secondly, it is clear that students are more comfortable with assignments that involve literature searches followed by essay type reports and struggle more with technical topics and specifically programming (MATLAB). The adoption of FLASH lectures has made a substantive improvement on student perceptions and progress although it is clear that a sizeable group are still requesting a more lecture-led approach to MATLAB, and thus there is still more work to be done although it is unrealistic in practice to satisfy all students simultaneously.

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