Run, Pause, Rewind: Increasing Student Agency Through Video Led Workshops.

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Biology is becoming an increasingly data-rich science, and the modern biologist needs skills in data handling and analysis. However, more than a third of our new entrants do not have a post-16 mathematics qualification.[1] This poses a challenge to engage those students who lack confidence and skills in embracing the more mathematical components of a modern biology degree.

In this case study I demonstrate how the teaching environment has been adapted to enhance student engagement and learning for complex tasks. Mathematics and computational analysis require the mental construction of abstract models in working memory.[2,3] This is mentally taxing, especially where the student has little experience of the topic so cannot readily use that prior knowledge (in long term memory) as a scaffold on which to build these new representations. Tutor guidance is required to support this learning.[4] The challenge of constructing novel complex mental models is well accepted in popular culture e.g. the 'Maker Schedule' [5,6] and in the literature where it is shown that interruptions in working with such novel tasks can have a deleterious effect on productivity.[7] The shift of focus from one task to another requires effort [8], and the work of returning to the original could in many cases be excessive if the task involved a novel mental model that was not extensively supported by previously learned knowledge.[9,10] Likewise, presenting novel mental models too rapidly, with insufficient time to practice can lead to cognitive overload, with the students unable to follow and becoming demotivated.[11]

Our IT based stats, mathematics and programming classes are typically in 4 groups of 50-70 students. When leading a class it is clearly desirable to have all students able to follow the material. Traditional teaching from the front (TFF) dictates the starting point, the pace and the content for the students in that session. With a diverse class this requires that we proceed at the pace of the slowest with frequent *forced interruptions* for the whole class as errors are corrected. These interruptions leads to demotivation of the more able students through boredom, with a negative effect on attainment [12] In addition the TFF class environment constrains students who wish to experiment from doing so, for fear they would be left behind if the instructor moves on with the material. With these technical subjects, much of the true learning comes with exploring in depth around the concepts rather than rehearsing a predefined set of instructions, so TFF works against learning in several ways. Achieving the learning objectives becomes a Sisyphean task where novel constructs are repeatedly destroyed before effective learning has taken place. Our challenge as educators is therefore to reshape the classroom environment to meet the needs of the students for learning.

As part of our developing curriculum, I introduced a Scottish level 2 bioinformatics practical which has several linked tasks, each of which involved complex new concepts and were sequentially dependent. It was clear that the TFF model of instruction was unsuitable. Small group teaching would be ideal but was impractical for a large cohort. The solution had to be student-centred, giving learners both agency and responsibility via self-regulation over their learning, fostering key qualities of the life-long learner.[13] This would include student autonomy over their learning at a pace which suited them. To meet these objectives I prepared a series of video walk-throughs that took the students step by step through the practical. The videos were completely subtitled, with key commands highlighted. Students were instructed to bring headphones and another device if they wished to maximise their learning.

The change in the classroom was astonishing. From one class of sixty to effectively sixty independent classes of one. The students gained agency over their own learning. The control of the lesson was in each student's hand. One click and they could pause. Another click and they could rewind to review. There was no fear of being left behind so they had opportunity to practice and transfer knowledge. The teaching mode had become a self-regulated learning experience. From a lecturers perspective, because every student had a clear view of what is going on, there were many fewer simple mistakes. Instead of spending time firefighting and becoming increasingly exhausted during a day filled with multiple sessions, I was able to take time to discuss with students one by one. I was talking science, not syntax.

After the first session many students were working on multiple devices - a phone or tablet for the instructional video, a laptop for the worksheets to take notes, and the IT suite computer to work with the bioinformatics software. The room had a quiet energy and clear increase in engagement. The student feedback was exceptionally positive with many requests for this teaching method to be applied to other areas. There were no negative comments. Evaluation of student outputs also demonstrated that they had not only achieved the learning outcomes with higher perceived engagement but many were exploring outside the boundaries of the set work. The inevitable forced interruptions from the TFF classroom had been removed. Any interruptions now required deliberate decisions on the part of the student. Sisyphus has made it to the top of the hill.

Figure 1. Two students share a pair of earbuds during a stats workshop

The following year, having demonstrated the value of this style of teaching both to myself and to my colleagues,   I transferred many more workshops, primarily introductory statistics and bioinformatics data analysis to video-led sessions. My enthusiasm (and results led several of my colleagues in using the software to generate videos for use in their own teaching in fields as diverse as enzyme kinetics, pH calculations and FACS analysis for immunology. Students self-reported returning to and reusing the videos when applying knowledge to future work.

My reflections on the impact of this teaching method revealed that there still remained one source of distraction, and that is the student who needed help. Students who required assistance would put up their hand and start trying to attract the lecturer's attention. I noticed that at this point the student is no longer concentrating on the workshop and sometimes would distract students around them. I also noticed that students became conflicted between stopping to seek advice and progressing with the workshop. The solution came in the form of a small plastic duck. In a concept adapted from the Software Carpentry movement[14], I no longer permitted students to put up their hands to seek assistance. Instead they would place an object (I introduced this with 20mm plastic ducks as a memorable concept) on top of their monitor to indicate they need assistance and they carry on working. It worked. Students who wished to discuss a topic could do so without impact on progress. I also noticed that a significant proportion of students who put up their duck would then carry on to solve their problem and take them down again. Exactly what didn't happen when students had to put up their hand and wait for assistance. I enthused my colleagues with this approach and we have now used this school wide for all IT based workshops this academic year. The overwhelming consensus from my colleagues and the students is that it is effective and enabling. In addition, small ducks (and other animals) are great prizes to give out for answering questions in lectures.

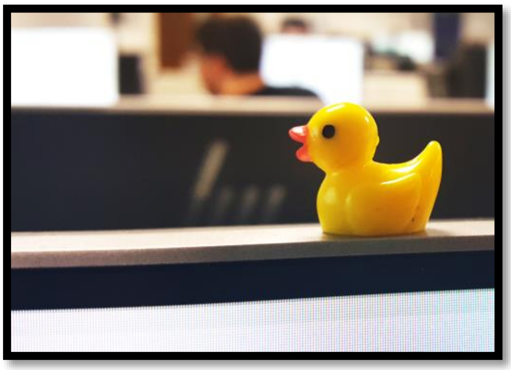

Figure 2. Two 'ducks' indicating that their owners need assistance during a bioinformatics class.

Now after several years developing this approach we are in a position where most technical workshops introducing new concepts have guidance videos. These 'first generation' videos are by their nature step by step guides. Whilst helpful, this does not yet reach the potential of the medium. The students need to not just watch the video but to be able to understand and translate them to new contexts.

Are videos appropriate for all situations? Absolutely not. Where new knowledge is being introduced in the absence of pre-existing conceptual frameworks they work well. Where the aim is the translation and reinforcement of previously learned material then they are unnecessary, and perhaps a hindrance. A task described at a higher level such as 'import the data and plot certain columns' requires the student to apply previous knowledge (potentially gained through video-led instruction) and is constructed from information held in long term memory. If the detail is missing then students are referred to the previous workshops on the VLE where the videos are available.

On reviewing the earliest videos, it becomes clear that a major issue with video is that it is inflexible. Once they are made they are fixed. This becomes a challenge as IT upgrades; new versions of software can have a different look and feel and the video does not exactly reflect the student experience. All of these challenges can be turned into learning points when required, leading students to understand that the video is a guide, not a prescription and enable transfer of knowledge to different situations.

The move to video-led workshops was a move that I was nervous about, but was driven by the knowledge of what the outcome was likely to be otherwise. The time investment is not to be underestimated though the physical resources are modest - a PC with the free OBS Studio software

[15], a microphone and a quiet office. The impact, however, has exceeded all my expectations. Students are engaged and enthusiastic about the topics instead of disengaged and discouraged. Student feedback is excellent - it is a method that works for them and places them in control of their learning. Tutor feedback is also excellent. The workshops dramatically enhance the relationship between lecturer and student. We can discuss the science rather than being pulled away to deal with trivial errors. There is a solid basis in cognitive psychology for re-engineering the workshop environment to meet the needs of the students, and the students gain agency as they are in control of their learning.

One question remains - why did I wait so long?

[1] 2018 cohort admitted to Life Sciences or Anatomy/Forensic Anthropology degrees: n=281: 184 held a post 16 qualification (SQA Higher/Advanced Higher, A/AS-level, IB or Irish Leaving Certificate) in mathematics.

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