DULTA portfolio

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Contents

Integrity Sheet

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Checklist of Coverage of Learning Outcomes K, A and V

K **Knowledge and understanding of:**	Tick	Reference(s)
K1 relevant subject material in my field;		Chapters 2 and 3
K2 appropriate methods for teaching and supporting learning in my field;		15
K3 how students learn, both generally and in their subjects;		10, 15
K4 the use of appropriate technologies to support their learning;		11, 13
K5 how to evaluate the effectiveness of my teaching;		14,15, 11
K6 the implications of quality assurance and enhancement for my professional practice.		12, 15
A **Skills and abilities to undertake at least four activities drawn from the list below, which must include A5 and A6:**		
A1 design and plan learning activities;		7
A2 teach appropriately and to support student learning;		10
A3 assess student learning and give feedback;		
A4 develop effective learning environments and support and guide students;		
A5 integrate scholarship, research and professional activities with teaching and supporting learning;		12
A6 evaluate my practice and plan continuing professional development.		14

V **Appropriate values of:**		
V1 respect for individual learners and diverse learning communities;		10, 15, 9
V2 promote participation in higher education and equality of opportunity for learners;		10,11
V3 use evidence informed approaches and the outcomes from research, scholarship and continuing professional development;		12, 15, 11
V4 acknowledge the wider context in which higher education operates and recognise the implications for professional practice.		12 14

1 Teaching context

Since I started my undergraduate studies in Theoretical Physics at Universidad Complutense de Madrid (Spain) in 2004, I have been involved in science spreading activities and workshops. During my ERASMUS year in Nottingham, I was also involved in the Student Associates Scheme (SAS) for 10 months. In 2010 I joined the Atomic and Molecular Physics (AtMol) group in Durham, where I started my PhD in experimental physics.

During the first year I reflected on my learning, and whether the teaching that I had received in the past was "good". How do we define good teaching? Ultimately good teaching translates into students' learning, but the process whereby this "optimal" teaching is achieved seemed to be rather complicated – and interesting. This pushed me to be involved in outreach and teaching activities in the subsequent years.

I started my teaching activities as a computing demonstrator for Physics undergraduates in their third year. The weekly classes were typically 3 hours long and run for 8 weeks during a term. The typical class size was 40 students, and I was involved in teaching 4 groups spanning two terms. The first four weeks are devoted to rehearsing their programming skills by carrying out a scripted "milestone" problem. However, the rest of their time is spent extending the program that they developed in the way that they find most appropriate. In the end, the students have to produce a report in the format of a research paper where they summarize their findings during the 4 weeks of unscripted research. This report constitutes the main contribution to their assessment marks.

In this module, my duties as a demonstrator were to assist in the delivery of the classes as a Python *expert* (along with another fellow demonstrator), and to guide the students in the use of a computing language (Python) to solve physical problems. The presence of demonstrators in the computing class helps create an effective learning environment by reducing the impact of programming pitfalls in the development of their project. I chose this specific module because programming is an activity that I enjoy and I use on a daily basis. Using it on a daily basis allows me to build a link between my research and the subject of my teaching, where the experience flows in both directions; enjoying it, being enthusiastic, can build a link between me and the student, and can enhance their motivation towards the subject matter [1].

Another teaching activity I was involved in was the bridge Project for second year Physics undergraduates. This activity counts 20% towards the total mark of second year module "Laboratory Skills and Electronics" [2]. The project is a one-week creative activity that happens at the end of the first year. In each project, given in the form of a problem for groups of four, the students carry out unscripted research under the guidance of a member of staff where they learn new practical and theoretical skills. This is a complement to the scripted laboratory practicals that they have performed during their first year, and the first time they have the chance to do creative research. During the week, they write entries in a blog to report their daily progress (as some sort of laboratory notebook) and a wiki to summarize their findings.

Among my tasks as a supervisor were to choose the equipment they used, plan and adapt their work and, jointly with an external examiner, assess their work; other tasks were promoting safety regulations in the lab as well as enhancing good laboratory and scientific methodologies. I met with the students about one hour each day to discuss the project, both in terms of the "big picture" (planning and guidance) and the technical details. In addition to providing oral feedback, written feedback was also given in the form of a daily entry in their blogs. As my presence in the lab was limited in time, this entry in their blogs would constitute a plan for their subsequent research. Towards the end of the week, I informally interviewed the students and gathered some feedback on their experience and my teaching (see Section A.1).

Apart from the academic modules, I was also involved in planning an outreach activity for the 2012 Durham University Schools Science Festival. The Science Festival attracted 23 schools with 699 students over a three day period. The activity that we presented, called "Enlightening!" ran 8 sessions per day of 25 minutes each (plus 5 minutes change time). The aim of the activities was to engage students and encourage wider participation in science, and to support young scientific minds from the local area. We received some feedback from the organizer body regarding the activity (see EVIDENCE, not yet)

Finally, I have taken part in a video review session where I have been assessed giving a talk about Physics. The participants, all of them undertaking the DULTA course, were separated in groups of 3 or 4 and each of them presented during 5 minutes. The rest of the members of the group provided feedback to the presenter verbally and through the DUO electronic platform (see A.3). I have used the feedback provided while designing new presentations, retaining the main good points (my inquisitive nature and the usage of the media as a support in a non-dependent way) and working on the defects (project the narrative in a single line, not diverting the story).

2 Design and plan learning activities

In this claim, I will show my ability to design and plan learning activities. To do this, I will use my experience as a bridge project supervisor.

As pointed out in the previous section, the bridge project is a 1-week long activity where groups of 4 students carry out unscripted research towards the resolution of a problem. This project counts a 20% towards the module "Laboratory Skills and Electronics", whose description can be found in the Durham online Faculty Handbook [2].

Quoting from the mentioned description: *"[In the bridge project] ...Students will work in teams on an extended project lasting one week, which will develop their problem-solving, teamwork and presentation skills"*, we can identify the three areas of focus of the bridge project:

- Problem solving skills (this includes laboratory skills)
- Teamwork (as part of the Key Skills in the Learning Outcomes)
- Presentation skills (another Key Skill)

These are the most important guidelines for the course. Staff members were given a module briefing where the module aims, learning outcomes and recommended practices were outlined.

In order to assess student learning, the students need to give a presentation of their results, with the help of the wiki they have developed, in the afternoon of the last day. They are also assessed by their blog entries during the week, which should show their teamwork skills.

Although the course was already given, the creative nature of the project requires to plan student learning during the course of the activity.

This task takes place at two different times:

- Before the activity: to guide the student in an efficient way, it is important to prepare both approach and materials required to carry out the project.
- During the activity: the random nature of the group's skills and interests, and the individuals' diverse learning preferences makes planning in advance a hard task. Furthermore, the unpredictable nature of research requires flexibility in the response of the supervisor and the limit in time requires efficient planning during the week to obtain results.

The problem that the students were given was: do "Rattlesnake Eggs" cause a finite time singularity? "Rattlesnake eggs" are a pair of oval hematite magnets. When the two magnets collide, they vibrate and make clicking noises at an increasing rate. The question is to see if the time between bounces or "clicks" approaches zero in a finite time.

The first thing I did when approaching the design of the activity was to contact the previous year's supervisor, which gave me some insight about the problem at hand. One particular thing that attracted my attention was the fact that the signal-to-noise ratio (SNR) [3] of their data was very bad at high rates - that is, when the clicks are approaching the singularity. This means that useful data cannot be separted from irrelevant noise in the region of most interest, so one must take care over the confidence with which the question can be answered. The "scientific soundness" of the results would, therefore, be the approach that I would take in my planning. It *adds value* to their learning and supports the learning outcomes of the module as well as the wider aims for the education of scientists (*"fitness of purpose"* [4].

In some previous years, the supervisor gave the students a computer program in Python with a model of a bouncing ball that the students could rudimentarily adapt to try to simulate numerically the physical situation they were encountering. I preferred not to introduce them to Python (since they were going to work on it during the rest of the module) and let them work with the skills they had. Although seemingly "regressive", not giving them the answer directly and letting them work with more rudimentary programs (spreadsheet software, mainly) can help them understand in which contexts programming actually helps, and what its value is.

Another task that has to be performed before the activity is the material provision. Apart from the magnets, the students need a microphone to record sound as electrical signals. The signals produced by the microphone need to be recorded and analyzed. To this end, one normally uses the –sometimes undervalued– oscilloscope and a computer.

The first instrument that is required is the microphone. Based on experience from previous years (I asked the former conductor of the project), I was aware that the quality of the microphone plays an important role in the data taking procedure, especially at high rates/frequencies. During previous years, the internal microphone of the laptop was used, but the results could be improved. Therefore, another, standalone microphone was provided[1] to the students.

This year, the students would use a new USB oscilloscope that plugs directly into a computer. The module is much less intimidating than its standalone counterpart and has the advantage that both programming the oscilloscope and taking data was done directly in a computer, which makes the data readily available to the students. This can be compared with the use of a usual oscilloscope, where the data taking and data analysis happen in two different devices.

If we combine this oscilloscope with the use of a laptop, the computer available in the lab, we are creating a more mobile and flexible laboratory that enables computing power whenever and wherever experiments (and learning) occur (see Chapter 5 of [5]). The laptop is required for students to analyze data, as well as to write their daily entries in the blog and the development of the wiki. Furthermore, not having the oscilloscope tied to a particular computer facilitates students' use of their own computers to take and analyze data, creating a more effective environment.

Approach and materials: checked. What next? Although careful planning of the activity during the week can be a futile task, having a rough plan is useful, both as a guiding principle and as a reality check.

There were only three compulsory activities for the group during the week: safety forms needed to be filled before any experimental activity, they have to write individual blog entries daily and the wiki had to be finished by noon on the last day of experimentation. These needed to be taken into account in the week plan.

Having all these constraints and in mind, the preliminary schedule[2] was:

- Day 1: Safety checks. Familiarize with equipment and basic physics.

[1] Most laboratory provisions and resources are handled by the laboratory technicians – to whom I am indebted for the smooth running of the lab.

[2] Blog and wiki contributions are omitted because they are supposed to be daily.

- Day 2: Identify tasks and main sources of error.
- Day 3: Data taking. Design method for data analysis and refine experiment. Focus on SNR.
- Day 4: Data taking. Interview. Finish wiki.
- Day 5: Final touches. Presentation

The activity is severely constrained in time (only one week), which makes feedback a very important issue for the correct evolution of the activity. The module briefing recommended a daily 30-60 minute meeting with the students. I sent an email before the beginning of the activity to check what the time of our first meeting would be. Another source of feedback for the students were my entries on their blog, where I would sum up the areas to work in during the following day. This would allow more reflective students to pick-up on my comments in their own time.

Finally, in terms of feedback, I also planned an informal interview with each of the students during the day previous to their presentations. The purpose of the interview was twofold: to make sure they have understood what they were doing during the week and to evaluate my practice. In this way, I have another source of feedback about my teaching activity. More information about this interview can be found in Section 5 and A.1.

3 Teach appropriately and to support student learning

The following claim aims to show my ability to teach appropriately and to support student learning.

During the past year, spanning a large part of the second year of my PhD, I was involved as a demonstrator in the Level 3 Computing Course. The course introduces the students to the use of numerical methods in the resolution of physical problems. It aims to develop transferable skills in researching a topic and making oral and written presentations on the findings, to develop computer skills and practise and reinforce basic physical concepts.

This part of the course consists of eight three-hour sessions. Half of them are devoted to Python revision and the numerical solving of a posed problem or “milestone”, which contains in itself the basic physics and techniques of their projects. The rest of the sessions focus on extending the project in a direction chosen by the students and to produce a report based on their findings. In the classes there are three “experts”, that guide the students through the physics of their projects and are the main reference points in their development; and two demonstrators, that have two main tasks: first and foremost, to help the students with the difficulties in programming in Python, and the second is to ease the load of he experts, by helping the students with the physics. This involved, mainly, one-to-one interactions with the students.

During the previous year, the students have already learned Python, but although some of them remembered what they were taught, the reality was that some of them struggled with very basic programming tasks. The problem can be summarized with a sentence, attributed to Joseph Weizenbaum: “A computer will do what you tell it to do, but that may be much different from what you had in mind.”.

Some people are naturally skillful when it comes to programming. As a demonstrator, I approached them to check that their projects were going smoothly and, ocassionally, to tease them with questions about the physics behind what they were doing. Some people struggle with these set of skills, and my main task was to make sure that programming did not become a disadvantage.

As was noted by Tony Jenkins [6], both “deep” and “surface” learning come into play when programming. Surface learning may allow you to learn the syntax of a programming language such as Python, but deep learning is indispensable to build competence. Programming is an activity that requires multiple skills and multiple processes running along at the same time. The processes involved are, first, to translate the specifications of a given problem into an algorithm, and then that algorithm into program code.

Most students have learned Python syntax in the previous year and have the required problem-solving skills that would allow them to face any physics scenario they are presented with in this course. However, there is a subtle difference between knowing how to solve the problem and translating your thoughts into an algorithm that a machine is able to process. And this is the kind of deep learning that is the object of computing classes.

During the first two sessions of the course, they are provided with a chance to try what is called “pseudocode” to solve the milestone project. This is what Jenkins identifies as the intermediate step between the two processes defined above, and is thought as a support of the learning process.

Given this situation, in order to provide useful support, not only in the computation classes but also in the scientific development of the students, I used a question-driven approach to support learning. This approach consists of not directly giving any answers, but rather letting the students work the answers out by themselves under the guidance of the demonstrator's questions. I learned this approach in a training course by *Planete Sciences* [7] and it is a somewhat similar method to question-driven instruction (QDI) [8]. The differences between QDI and this method is that QDI is a complete framework that can deal with a large number of students, whereas my method is applicable to a small number of student in a less structured environment, which allows for more personalized feedback given that the short-term outcome is easily visible as the program evolves and the problems are solved.

It is a "scientific approach" to learning science, where the problems are tackled from the questions they try to solve, and the assessment consists on the agreement of their results with the values in the literature. It also conforms with the constructivistic approach [9] in that the knowledge is constructed by the students, as the answers to their problems are obtained by them, and the instructor is a tool that facilitates this task.

In order to implement it, for example, the first questions that I used to assist problem solving were, usually, open ended ("What do you think the problem is?", "How can you describe what's going on?", "Could you draw a picture of the data?"). However, the subsequent questions become more and more particular to the problem ("Reading the debugging data, what can you infer?", "If you cannot store this data in this way, in which other way would you do it?", "Python is fast in vector operations; do you think you can vectorize this function?").

This question-driven approach is hard to apply –i.e. more effort is required from the demonstrator in the wording of the question– if a lot of technical knowledge is required and hard to access. However, the fact that every student was working with a computer made the task to look for an answer easier for them. Thinking about how people learnt in the past, one could argue that one of the bottlenecks was information spreading and acquisition, as there were limited copies of key works and they were not instantaneously available to everyone. If you have a computer connected to the internet, obtaining data and facts is sped up, and the instructor can focus on deep-learning. A very technical detail can be solved by looking at an online manual, and examples of coding can be easily accessed. Therefore, feedback regarding menial details become instantaneous.

But, does this method work? There are some examples in the literature, like the one of Rick Garlikov [10]. At the beginning, the constant questioning might appear intimidating to the student and the lack of answers is puzzling, especially for those students who are used to obtaining direct answers from instructors. On the other hand, it soon becomes normal, and I found the method to be useful, as you could readily tell when a person has understood a concept by just simulating a slightly different scenario. This is possible because Python allows you to change parameters and functions and see the outcome in real time.

There is a big number of technical problems that can appear when you program Python for numerical purposes; therefore, the fact that the students slowly became aware of these problems and stopped having them is indicative of their learning. Finally, as the questions go from the general to the technical,the demonstrator focuses on the particular problem that the person has; this kind of communication becomes, in the end a conversation between two people, which enhances empathy between both parties.

4 Integrate scholarship, research and professional activities with teaching and supporting learning

After having done some outreach in Spain, and being involved in the Student Associates Scheme in Nottingham for 10 months, I had some time during the first year of my PhD to reflect on the way teaching happens. I have to say that, although the experience in Nottingham was very positive and having received feedback from my supervisor, I was not sure at the time that teaching was the thing that I wanted to do. However, this feeling was inspired by a misconception that, I think, is common amongst undergraduate students: either you do research or you teach, but it is not possible to be good at both.

It is possible to find in the literature inconclusive evidence regarding the teaching-researching dicotomy [11, 12, 13]. The issue has raised many concerns in the past few years, with Higher education in the UK facing major funding cuts [14].

I have been in contact with very positive models (both in Spain and in the UK) that have shown me that, contrary to my misconception, subject-specific research and teaching are activities that, as well as being complementary, share some techniques. Furthermore, Healey and Jenkins [15] argue that all undergraduate students "should experience learning through, and about, research and inquiry".

Let us take a look for a moment at the learning process. This process is inextrincably related to experience. This concept of "experiential learning" was developed by Kolb [16], and can be put in the context of the "experiential learning cycle". Kolb's cycle, like the scientific method, involves *concrete experience*, *reflective observation*, *abstract conceptualization* and *active experimentation*. It is, then, possible to draw analogies to these concepts from the hypothetico-deductive method [17]: *experience*, which can be data gathering, previous explanations,...; *hypothesis formation*, which is trying to formulate an explanation to the observed phenomenon; *deduction* of predictions from the (general) hypothesis; and *testing* or experimentation.

There are some obvious differences between the two: the knowledge gained in the scientific community is a very slow process, which needs to be squeezed in time in the learning process. Also, most of the techniques that the students need to learn are pretty well known by the instructor, whereas the researcher is, sometimes, alone in his pursuit.

In the light of this analogy, given the similarities between scientific research and teaching/learning activities, it is possible to make a connection between the two – especially when the research field is connected to the teaching activity, but not only limited to that case.

The way in which my research and professional experience have impacted my teaching can be understood in two ways: familiarity with the material to be learned, and the addition of new knowledge and skills.

Familiarity of the teacher with the material makes knowledge and skill transfer easier (this, by no means, implies that knowing the material makes you a "good" teacher). Obviously, reflecting upon something yourself helps facilitate deep learning of others, since you have tackled the same question several times, possibly from different approaches. Let me draw an example from the computing class to illustrate this point which concerns visualization of scientific data. Whenever you have a complex dataset, the representation of the data impacts the interpretation of the results, revealing trends or highlighting important situations. This can be easily shown if we compare the data represented in the form of a table or a spreadsheet and that data represented as a plot. That is why data visualization has drawn a lot of attention lately [18, 19].

The students from the computing class (see Section 1) often asked me the question "How do I plot this?" (especially in the context of 2D representations of 3D data), which shows a lack of knowledge of the visualization techniques and/or the features of the particular programming language they were using. I then used my research experience to help them. First, I drew their attention to the particular problem that they had, and asked them what was the *subject* of their plot. This is a key part of the process, since my experience shows me that students are not familiar with what "plotting" actually means and requires (see, for example, [20]). Then, I could direct them to some of the plotting capabilities of the programming language they have used (and I am familiar with), either by pointing them to suitable online resources or manuals. Since my teaching method involved witholding direct answers to their questions, I tried not to give them function names or case uses, but rather let them explore different possibilities to promote deep learning (see Section 3).

The other way in which professional experience and research has impacted my teaching is in the addition of new knowledge and skills that I can use. One of the first things that I have learned from my experience in *Planete Sciences* was that letting people think is the only way in which we can promote deep learning. In words of Jennifer A. Moon, "It is noticeable, too, that one of the defining characteristics of surface learning is that it does not involve reflection" ([21], p. 123). Also, the interaction with my supervisor has shown me that the most important thing in research is asking the right questions.

One of the most important questions in scientific research is "Are your data consistent with your hypothesis?", or "Is your claim supported by evidence?". I used these questions to guide the plan of the bridge project (see Section 1), to inform their learning with scientific soundness. This is why the group spent a lot of time analyzing the data, understanding the errors and concepts like the signal-to-noise ratio (see Section 2).

But, of course, the relationship between research and teaching is not unidirectional. My teaching-related experience has also influenced my research.

Since attending the DULTA training courses, I have been aware of the institutional strategies regarding teaching and supporting learning. Placing my own research in this context is, of course, beneficial, as it allows me to identify and focus on the important aspects and key skills.

Reflecting upon students questions in classroom (especially those in the computing class) and guiding them through problems has taught me several important bits of the Python computing language.

Finally, being able to direct the bridge project has given me the opportunity to be "on the other side" of research: research advisor. Now I have a better understanding of the role of the advisor, and that has improved the communication with mine.

5 Evaluate my practice and plan continuing professional development

In this final claim of my portfolio, my aim is to show my ability to evaluate my practice and my commitment to develop my skills in teaching and learning. I will use as example the activity that gave me more freedom in terms of teaching: the bridge project (see Sections 1 and 2).

Unscripted research means that the students are given a question that they have to try and answer in whatever way they consider appropriate. The supervisor's role is to plan and guide their research during the week. The strict limit in time makes planning the daily tasks very important.

I would meet all of the students in the lab at an agreed time during the day and discuss how the project was going. In addition to this, I passed by the lab a couple of times a day just to see how things were advancing.

Apart from laying out the terms of the research – that is, specifying what were the outcomes of this activity and the methods whereby they were supposed to be met – the way in which I interacted with the students was similar to the question-driven approach I used in the computing class (as described in Section 3). My approach was an inquisitive one, where instead of giving definite directions, I would ask the students what they wanted to do and how they were going to do it. In my opinion, asking –rather than imposing– gives more freedom to the student and makes the experience of research much more rewarding. Sometimes, however, when things were not going "according to plan", that is, when the performance was deviating significantly from the learning outcomes, I would state clearly what they were, indicating in which area they needed to work. For example, some of the students did not update their blog entries frequently or giving enough details, so I suggested them to change that trend; another issue was that some people were updating the wiki but not all of them were contributing to that task, so I asked the rest of the people to collaborate.

During the last day, I interviewed them individually and asked them some questions regarding the course (see Section A.1). The interview was done in a public place were they could feel relaxed and talk to me freely. Most of the questions were open ended. The answers to the first two questions showed the nervousness that they had, but after 5 or 6 minutes they would relax. The feedback was quite positive, and all of them thought that the bridge project had helped them understand the question at hand, as well as to have a greater understanding of the underlying physics and applied methods.

There were, however, several answers to the question "Do you have any comments regarding my supervision?" that were focusing on the lack of information. One point was that the lack of clear answers was was slightly detrimental as they needed them to go forward. However, most of them agreed that it is also true that this method probably made them think more deeply in the subject and understand it better in order to progress.

Although seemingly inoffensive, the comment about the need for answers made me question whether the method of questioning was appropriate in the context where I am supposed to be guiding students. Looking at my approach, I reckon that it might be very difficult for a student to make sense of a situation in which he/she is not told what to do. This might be especially true during the first year of their higher education, when they are used to the "lecture" type of learning, and they require more directed support, instead of using questions.

There were, however, some points that, in hindsight, did not work that well: first, I think some of the questions that I posed were not as effective or directed to the point as they should have been. For example, asking them to tell me "what was happening?" was too broad, when I could have asked "what is happening in the oscilloscope?" or "what has changed with respect to the previous trial?" Second, I realized that one of the students was particularly shy. I did not, however, change the method when addressing him, in part because I did not want him to feel different from the group, to promote equality. These points could be improved.

Since my reflection period, I have been able to find resources that deepen into the subject of questioning and I found out that there are ways to improve the method: for example, [22] and [23] show that there are many ways to question to enhance deep thinking, and that the answers are highly dependent on the phrasing of the enquiry. Therefore, something that I need to improve upon is to practice and control the kind of questions that I choose. Another way in which I would improve the method would be to ask general questions, to be answered by any of the people in the group, and then direct questions to specific members of the group. The answers can then be verbal, if it has an easy answer; written, if it requires more reflection, or experimental in nature. In this way, I can make sure that active learners feel free to answer (the general) questions whenever they need to and let the reflective learners time to think about their answers until the end (see Felder and Silverman, from [24]).

If I had the time, I would also introduce another element of assesment in the middle of the activity.Obviously, in such a short activity, it is very difficult to assess what is the impact of your actions before the group has effectively collaborated and shown some progress. The interview I had at the end of the week allowed me to understand better what was going good or bad in their learning, but it was late to provide the students with more feedback . It would be very useful to meet with the students individually at least once a week (for longer activities) to assess them individually and address their difficulties and concerns.

Finally, in terms of professional development, my aim is to continue the teaching activities. As a result of teaching, I have compiled a list of common mistakes commonly made by students and sent them to the course leaders of both third year Computing Lab and the second year counterpart. This year, I am enrolled in the first year Computing Lab. I chose this activity given my previous experience in more advanced classes. Using the distilled experience that I have obtained, I hope to better support students' learning.

A Evidence

A.1 Bridge project interview

Answer to the questions outlined below by the four students (A,B,C and D) participating in the bridge project (see description in Section 1). The interview was done in an informal environment. The answers have been phrased, highlighting the main points.

The first question aims to get the student talking and feel more confident about the interview. The second and third and fifth questions try to determine their contribution to the project and if they have really understood the physics. The third question was phrased so as to "excite" them to give an interesting answer. The fourth question is an auto-evaluation for the students. The sixth provides the supervisor with feedback.

Questions:

- 1.- What did you think the project was? What it ended up being?
- 2.- What is your contribution to the project?
- 3.- Trick question: what would be the difference in the project if the magnets were cubes instead of ovals?
- 4.- What have you learned about the project?
- 5.- (Added after A) Limitations?
- 6.- Do you have any comments regarding my supervision?

Student A

1: Collecting data every day and experimental side. Actually: Think about what you are doing. Documenting as you go along. Scientifically sound.
2: First couple of days, mostly contributing with C and D to setting up the experiment. Last couple of days: Taking data. Some pages on the wiki.
3: The oscillation about the ends would be limited (some discussion on the physics involved)
4: Specific example of magnetism. Oscilloscope software. Writing the wiki: Documenting things in a different way from a lab report. Wiki is more flexible, make things more interesting, change the audience, reduce formality. Labbook: not good for explaining.
6: Helpful giving advice. Tell what to do without being obvious. Explaining to oneself makes better thinking. Amount of time devoted to the project is good.

Student B

1: That would be simpler but it ended up being difficult. Every day was a new idea.
2: Contributed in most tasks. Some practical work, some on analysis: most of the theory and modelling. Progression with the group: good in general, we don't get frustrated with each other.
3: The results would not vary: still oscillating back and forth, still energy dissipating. (What happens with the edges?) More dissipation, stop going faster. Stop oscillating in shorter time
4: Excel: pros and cons. The "goodness" of programming. Physics: oscillations, more insight on the subject.

5: Signal to Noise ratio, specially at later times. Hardware (but every hardware has its limitations). Better way of analyzing data
6: Good but: slightly cryptic sometimes. Should have more definite advice about things. Although we should be self sufficient: that's why not giving all answers.

Student C

1: Wasn't really sure about the results or hardware, as I haven't done anything like that before Now: It makes sense. Interesting. Enjoyed! Work with data and in group.
2: Data analysis, main contribution: I know what I wanted, which is a plus. Once figured out how to do it, teach the rest. Helped with fiting (along with B). Errorbars. Have had help with blog and wiki.
3: Frequency will increase more quickly. Therefore, more force obtained force. Larger amplitude of shock: larger SNR but steepest descent.
5: Analyzing data: programmin would be useful. Repeatability: sensitivity in initial position means not getting the same answers
6: Tricky with theory, lack of information got us somewhere. Necessary: a bit more feedback on wiki and equipment?

Student D

1:Time of year not good. Thought a bit more like labs. Enjoyed the freedom and challenge. Now: Enjoyed more, but still having to learn. Design an experiment fun.
2: A lot of things together: Excel, logic, solving problems, big amount of data. Wiki, discussion, problem solving in excel.
3: Similar result, shorter timescale, quickening collissions.
4: New skills (excel, oscilloscope,...) Group work. Freedom on where to direct the research.
5: Project: higher frequency recording. Noise from oscilloscope. The way to process data is not ideal: programming could help.
6: Pretty good. Seen us a lot. Feedback without explaining the things. Sometimes they want the answers but that defies the point. Updating things regularly and communicative.

A.2 Outreach Feedback

Add here names of the attached files

A.3 Video feedback

I hereby attach the feedback from the video review that I was involved in. The responses come from the two postgraduate students taking part in the same video review. The names of the people involved will be omitted for privacy purposes.

Person A :

Very good use of material; two problems I saw:

- First, a missing conceptual link (the combination of velocity to gravity to explain planetary mvt).

- Second, too many 'voices' in your speech: the questions of Newton, your own questions/objectives, and the questions of science. This issue lasted during the introduction of your subject, then disapeared as you progressed towards the technical and theoretical explanation.

Clearly, a v. good understanding and 'internalization' of the subject: I did not feel that you were 'bound' to your media at all.

Person B :

You took a non-scientific audience through Newton's contribution to our understanding of gravity. As (Person A) has said, there was a missing link (which you explained to us later) between exactly how the apple relates to the moon (I was wondering, if it's exactly the same force, how come the moon doesn't crash into the earth, and then you drew a cannonball, and now I know).

One of the main strengths was how your personality seemed to come through as you talked, and the inquisitive nature of you talk - you didn't simply present information, but you asked rhetorical questions that encouraged the listener to try and think through or answer them one step ahead, bringing us into the learning process.

As has also been said before, you looked like you owned the 'powerpoint'/Mac alternative - rather than you were a slave to it.

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