reflective practice

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abstract:
Reflective practise is an active, dynamic action-based and ethical set of skills, placed in real time for dealing with challenging problems. These techniques allow students to explore theories and to apply them to their own experiences in a more structured way. Students can use ideas from academic research or their opinions when reflecting. Fundamentally, however, by encouraging students to reflect, we are forcing them to challenge their own beliefs and assumptions and to find solutions to problems by themselves.

In my talk, I will explain why I believe that embedding formalised student reflection into STEM courses is of such vital importance. I will then discuss a range of simple methods that can be easily and quickly deployed in STEM courses, the majority of which I have already employed in the classes I teach.

participant's summary

Teaching using online resources is hard. Students can watch the videos you make but it is difficult to know whether they are engaging with the material if you do not see them in front of you. Even if the students are in front of you it can be difficult, however, because you have no way of knowing whether they are understanding what you are saying and how they feel about the way you are teaching them.

The assumption in much of our teaching is that you can tell people things and they will understand them. Making mistakes is an important part of learning, however, and is something that happens even when we are given detailed instructions. As a case in point just think about how often you have made a mistake putting together a piece of Ikea furniture. The mistakes you make are usually not because the instructions are unclear. Instead the problem is that we don't fully understand the instructions until we have completed our task. During our process of learning we sometimes ignore instructions believing that our past experience will be a better guide.

Given the importance that making mistakes has in learning we need to include more opportunities for formative assessment in our degree programs. We want to prevent students from making mistakes for the first time in the final summative assessments that ultimately determine the student's degree prospects. We also need to acknowledge that students can get most of the instruction that we provide in lectures from videos that most likely already exist. If we start to use these resources we free up our time, which will allow us to provide personalised feedback to students.

Students use 'imitative reasoning' (reproducing what we taught them). 'Creative reasoning' is what we assess in exams and final year project. We assume that there is a spontaneous transfer of knowledge between these two reasoning domains. In other words, we assume that students will automatically know how to use what they have been taught in lectures in the context of a final year project. This transfer does not always happen, however. We thus need to think about how to incorporate elements of creative reasoning in the way that we assess the content that we teach in lectures. There are three methods that I believe we can use to ensure that this transfer takes place:

1. We set project work on the module content that allows students to choose the level of difficulty that is appropriate to them.
2. We can use a flipped classroom model and use class time to probe what the students have learned outside the classroom.
3. We get the students to reflect on what they are doing.

Of these three ideas the third is the most important. It is vital that students understand what they are being asked to do and measures should be put in place in every course to ensure that the students are thinking about what the lecturer is asking them to do.

Getting students to reflect on what they have done is relatively easy. You can simply give them the task to write half a page per week on what they did, what went well, what went wrong, This activity is very revealing for lecturers as well.

Reflection can also be easily incorporated into a supervision approach. You can also use it to get students to think about the assessment activities. For example, you can do flipped marking whereby the teacher writes a report in a way students often do, with all problems involved (e.g. copying from Wikipedia). Students criticize this, and realize then how they should not write a report. It perhaps saves you from having to mark crap reports.

Another idea for incorporating reflection is to use peer assessment with feed-forward. For example, the students do a simple math problem in a paper book, a peer reviews it, comments, and then there is a reflection. At then end, the students are graded on the reflection and not on the math.

In everything it is important to think about the grading scheme: reproducing everything should be a pass, not more.

Final quote: The most important thing that happens in our classroom is learning, **not** teaching.

Q&A

Q: Being able to learn from mistakes requires conscientiousness and motivation; and it requires feeling safe (which requires parents with enough money to be spent)?.

A: The premise of this question is undoubtedly true. People with more social capital (i.e. affluent parents) will do better in this system than those who do not have this social capital. This same fact is true of **any** education system though. As evidence for this consider the "experiment" that has been done in the UK. We have dramatically increased the opportunities to enter the education system. In fact we have moved to a system where 50% of students now enter further education. In the same period, however, we have seen an increase in inequality. Furthermore, the pay gap between those with a university education and those without a university education has narrowed significantly. What makes this doubly tragic is that education in the UK is now considered to be a private and not a public good. Students therefore pay for their education through government backed loans. Students therefore leave university with huge debts that they are unable to pay.

By asking students to reflect we are asking them to consider their motivations and whether or not they understand. I find that too many students are going through the motions of doing a degree without ever thinking about what they are doing and why they are doing it. Reflection encourages students to ask themselves these questions. At the same time by reading what our students write we are forcing ourselves to think about what we are asking them to do and our own biases, which are informed by our own experience.

Q; Do you think that Project BAsed Learning (with access to compulsory and optional online content) would fit with this model?

A: Yes absolutely. In parallel to the reflection I asked the students to complete project work. I set these projects at four levels:

(1) The student completes a simple, scaffolded task.
(2) The student completes a well-defined task that is almost identical to the task they would have completed for task 1 but which is not scaffolded.
(3) The student completes a well-defined task. To complete the task they must use what they have learned from completing task 1 in combination with some material that they must find by themselves.
(4) The student designs a task of their own and solves it using the ideas that they learned about in completing task 1.

This structure works as students are given the support to start the process. They are also free to choose the level to which they will engage with the assignment. If I were completing this task I know that I would want to get full marks. Many students do not think like me, however. Giving them the flexibility to engage with the work to the extent that they choose is thus really useful. If you set the assignment too hard you will often find that you have to compromise when it comes to awarding marks. The more clear you are on the bare minimum and how to get the higher marks the more likely it is that students will produce good work.

Q: How to prevent that project work leads to superficiality (e.g., blindly copying code from Stack Overflow) and social loafing?

Possible A (Brian): Unique projects? Some compulsory online courses with robust summative assessment? Viva voce?

A (Gareth): Why do you care? You can lead a horse to water but you cannot make it drink. If students choose to cheat then they are only really cheating themselves. You have to hope that they will be found out later in life. When they go for an interview and have to answer something on the spot they will be caught out.

The students who succeed in education systems where students have to jump through many hoops are those who have a similar social background to the people who designed the hoops. These education systems thus serve to maintain the status quo.

We need to make more of an effort to explain the rules. We also have to justify the rules that we are making. Why, for instance, must the student solve problems in a three hour closed book exam? Why does it matter that they do the problem in three hours? What purpose is served by the student knowing the expressions for the probability density function, expectation and variance of every continuous random variable when they can easily look this information up online?

Consider it this way: would you rather a PhD student "cheated" by asking someone to check over their input files before they submitted their calculations or would you rather them burn through all the CPU time you have running calculations that make no sense?

I think that it is important that we frame these questions of what is "collaboration" and what is "cheating." The current systems make people feel that they cannot ask for help, which is problematic when they get into the business of doing research later on their career.

Most importantly, however, we have to understand that the vast majority of students will play by the rules. We shouldn't design the system to punish the minority of students who don't.

Q: you ask for reports on normal classes or on final year projects etc?

A: Both. For modules, for example, a useful strategy is to get the students to solve a problem that can be solved exactly using a numerical method. For example, you can get students to calculate the heat capacity for a particle on a harmonic potential using molecular dynamics. The nice thing about this approach is that you can easily tell if the codes that they have written are correct (as you know what the result should be) you can also get students to simultaneously engage with analytic and the numerical results.

I get really frustrated by final year projects. It is the wild west because what we ask of supervisors is not very clearly defined. I thus find that I am often asked to read through student work that is rather weak. I have no way of knowing, however, whether the work is poor because the student was poor or because they received poor supervision. Often the centralised instruction seems to be not much more than "write about 60 pages." If it were up to me I would

(1) Provide clearer guidance from the center on what is expected from each student. It is not unreasonable (for example) to state that a final report that has not been run through a spelling and grammar check will fail.
(2) Give students the opportunity to read and critique each others work before submission.
(3) Run workshops on writing that help students to prepare for the task of preparing their theses.
(4) Provide a report from the supervisor to the second markers in order to help the second marker to make a decision on the grade.

I have written a rather long document that includes more details on the assessment of final reports that I can share if anyone needs the time.

Q: What about the time needed to go through the reflective pieces

A: I had 30 students and it used to take me about an hour per week to read their reflective pieces. I actually quite enjoyed the process of reading what they wrote. I found it much more meaningful than giving them a further hour of lectures. In addition, this stuff is much much easier to read and mark than a page of mathematical derivations.

Q: All of this writing requires that students are able to write? (I mean, to write in a structured way with intelligible meaning.) What about ESL students, etc.?

A: If a student is unable to write about what they have done and how it has gone should they really be on a degree program? What I am asking them to write is much more basic than what we are asking them to write by the end of their degree; namely, a report on a piece of independent research that they have completed. I accept that university should be open to more students but there surely has to be some minimum standard.

I would argue that if a student cannot write about what they have done during the previous week and how their week has gone it is unlikely that they will be able to do any of the other work we are expecting of them well. Furthermore, the fact that students are encouraged to specialise too early in the UK means that many STEM students do not complete any significant piece of writing after age 16. When they arrive in the final year of their degree and when they are asked to produce a 60 page thesis this comes as a shock. We thus need to ensure that they are writing and that they are getting more feedback on the writing they are producing throughout their degree.

Q: Would peer assessment help? (you seem to be suggesting "yes") In large classes perhaps grading by the teacher is not critical.

A: Peer assessment is helpful. Take the current situation in my department. We collect in the work, graduate students (who are given a detailed mark scheme) spend 10 minutes per script putting ticks next to the problems the student got correct and crosses next to the questions that the students got wrong. We pay these graduate students something like £13 an hour for this work and by December of last year we had paid out something like £40,000

for this sort of work. If all these students are doing is putting a tick beside the answers that are right and a cross beside the answers that are wrong though this can easily be done by students who we do not need to pay. Furthermore, if we are having to provide mark schemes that are this detailed we can, with a little bit of creativity, automate the marking. I have, in fact, dispensed with graduate markers in most of the modules that I teach. I don't think that they are providing a valuable service to students and I don't think that this sort of marking is a good use of their time.

Q: would it be true to say that you are a fan of "competency" based learning? We are using the adaptive system aleks.com for first year engineering maths.
Force concept inventory https://www.physport.org/assessments/assessment.cfm?A=FCI

A: Absolutely. More than this I am a fan of systems where the learning is led by the students. I despise the language of meritocracy and "no child left behind." In a truly democratic society there cannot be groups of people who alone decide what constitutes merit and where the students should be. There will always be huge inequalities in such societies. Teachers cannot be expected to solve all of society's problems and inequalities in their classrooms. We have to make much more of an effort to meet the students where they are and to allow them to go at their own pace.