What sticks and should it? Students remind us of good practice.

Mark Coleman

In the beginning

On his Science exam at the end of Year Eight, Cornelius was asked to give an example of where he had seen / experienced / observed a number of the big ideas that act as throughlines for our course. One of those ideas is that "truth survives challenge". His response was," At the start of year seven we made a list of what a good scientist is and after two years of new Data this list is still correct."

My initial delight at what he wrote stemmed from the validation of my efforts that his response seemed to give. This boy had made reference to something that his class had worked on a long time ago; at least it was a long time for an early teenage boy.

I wondered about what it was that *stuck* with him. That is, what was the list that he was referring to? Later on, I began to wonder *why* it stuck. A bit of searching revealed the list shown below. These are a list of characteristics that his class thought described a scientist. It was developed early in their first term in secondary school.

I was curious to know if Cornelius was even thinking of this list when he wrote his response to the question, and if his views were held by other boys; not just his peers, but of those boys who had passed through my care some years ago.

The stake out

I staked out the school library at a time when I knew some senior students (Years Nine to Twelve) would be there; students who I had taught when they were younger. I first ran into Sebastian (Year Ten). I explained my curiosity and asked what popped into his head when given the same question; that is, what is it to be a scientist?

> *No idea… I just ... like ... testing ... just testing everything ... this is a pretty broad question. Trying to gather data. I guess just testing to gather data. Imagination – has to be physical, can't really be made up.*

I then asked him what terms on the list do NOT describe a scientist?

> *Compassionate. Wear a white coat*

Finally I wondered if he had noticed any differences between the nature of the course I delivered to him and that which he was currently experiencing.

> *"…not really ... we just go into more detail. .. a lot more tests ... they are good; they prepare you for exams."*

Jeremy then wandered past. He is in Year Eleven and studying Chemistry and Physics. I asked him what were the clear differences he noticed between the teaching of Science in the two sections of our school.

He indicated that the senior school is more structured in terms of the subject organisation. That is, chemistry, physics and biology are taught as discrete subjects rather than as elements of a general course. "It gives it direction", he said.

When asked if he was more comfortable in the senior setting his response was not so clear.

> "*Yeeeeaaaaahhhhhhhh* (a drawn out *yeah* rather than a cowboy's exclamation indicating excitement) ... *You get more questions to apply your work. Going into VCE it is good to have grades, but not at [middle school] … not as much pressure.*"

I asked Jeremy to look over the original list that Cornelius' class had created. I asked him which of the terms he felt didn't belong on the list.

> *"Original – because we have been doing the history of the models of the atom and that builds on the knowledge of others. Definitely not the highlighted ones."*

I found this interesting because it hinted that Jeremy did not have an open mind when it came to considering what *original* might mean in a scientific context. From the example he gave, it seems that he thought it applied only to the development of scientific understanding; he gave no apparent consideration to novel techniques or abstract thinking that may lead to new perspectives of the same data. In his two years of junior science, he was exposed heavily to ideas *of intellectual character* and the *thinking dispositions* (Ritchhart, 2002) and being open-minded was one of the dispositions most of my students associated with being a scientist.

From my initial investigation it did not seem that much had stuck with Sebastian or Jeremy and I began to wonder why this was so. I hoped that Cornelius' experience was not an exception to the *rule* that described my class room, but now I couldn't be sure.

The challenge

Some time later I had a quick chat to Freddie. He is currently in his final year of secondary schooling and, like Jeremy, studying Physics and Chemistry. I asked him a vague question about his recollections of his time in class with me. "*...easily [the argument between] you and Davidson … it was a good lesson that one … it was very enjoyable. It was amusing ...*"

Somewhat confronted by this I asked if he remembered any of the *science* I thought we had explored together. He clearly remembered two things; "*...those words starting with S (solubility, solute, solution etc) … [and] putting lids back on the chemicals … that was my aim, to get 100% on the practical [tasks]*"

Cornelius' responses were far better for my ego, but I persisted and pressed Freddie for examples of some differences between the classes in middle and senior schools.

> *"A bit stricter in [middle school] … they need to do [more]. [The experimental] reports for Physics; … the details [were] not as important [as they were in middle school].*

But finally,

"I think I enjoyed it because I had a good class"

I was troubled that Freddie's immediate memories of the two years we spent together were of an argument I had with one of his friends (a very placid friend at that), a list of words beginning with "s" and the importance of putting lids back on jars of chemicals to reduce the chances of contamination.

Sebastian and Jeremy agreed that wearing a white coat is not a prerequisite for pursuing science. I must admit, that was a relief. However, the difficulty they seemed to have in describing what it is to be a scientist troubled me. When they left my care I believed that I had helped all three boys develop an understanding of who scientists actually are, what they do and how they think. Had I gotten this so wrong? Had my students simply fooled me because they had mastered how my version of the *game of school (eg. Perkins – Making Learning Whole)* was played? Were they now playing a new game that had different rules, or were their minds Teflon coated? What was clear was that I needed to look at this more closely. I was confident that the courses I had offered my students and the environment I cultivated in my class room was showing them clearly how to think like a scientist. Now I was not nearly as sure.

Cornelius again

I resolved to ask more directed questions and go back to my original source. I wondered what Cornelius' perceptions were of how he was expected to think in a science classroom as he transitioned from middle secondary to upper secondary. I was hopeful that he would have a clear memory of what he had recently experienced and be able to contrast that to his current experience.

His responses are shown below.

> What are the characteristics you perceive a scientist should possess? (What is it to be a scientist?).
>
> > *Experiment, hypothesize, learn, curious, have to be able to adapt, like with modelling, you have to be able to change it.*
>
> What are your recollections / impressions of your Science classes last year and so far this year? (Comparison of the classroom cultures)
>
> > *[In middle school] I expected to learn and be challenged*

And I expected to be taught in a different way, like not hands up … everyone was in a circle so everyone had to put input into the conversation ... not slack off

[In senior school] I'm expecting to learn but in a more orthodox sense… it's like normal learning and you can escape doing things. You can escape learning in the sense that if you want to slack off you can, you aren't brought into the conversation. It's a different learning environment than [in middle-school].

Describe what you think a *typical* class looks like. That is, what are/were the class routines? (What is the message to the students about what learning in this class is like?)

[In middle school] you could expect that they would always be interesting; you could be caught off guard. It wasn't always the same people answering. Everyone sitting around facing the teacher, the teacher presents what they have to learn and umm then ...you had to contribute.

[In senior school] now you can really slack off a little in class and get the answers off others if you need to.

[In middle school] if you were caught not paying attention you were always asked a question. Even if the teacher knew someone was struggling or didn't know, the teacher still asked them a question ... they were forced to learn. Everyone learned more.

Which class do you think helps you develop the characteristics you listed previously? (Reflect upon the possible difference between being a scientist and a student of Science)

Before, you can learn what to do but it is not as natural. Like, only the people who already had some knowledge of those things were able to adapt now but before everyone was given the same opportunity to learn.

Do you agree with this list of "dispositions"? (Do they share your view of what a student of Science "looks like" and does it align with what they stated in part "a"?)

It is desirable for a science student to be disposed to:

- Be curious about what is around him and to actively seek answers to questions he raises. *Yes*
- Use all the resources at his disposal and to readily contribute to that pool of resources. *Yes*
- Work efficiently whether alone or as part of a team, showing a genuine sense of community. *Yes*
- Show interest in authentic learning tasks, indicating a genuine curiosity about the subject matter rather than the grades associated with it.

  Yes definitely. It also came in History … [In other classes] people would be shallow … all they cared about was the mark.
- Use discussions to further his own understanding and that of others in the process.

  Yes. That was in class when we had the big theory lessons. Everyone had to put something in and if they were wrong it didn't matter because they were still learning. If they were right they were teaching those around them.
- Place theory in an appropriate social/historical context.

  Yeah it definitely was especially the Atlantis [task] (A cross-disciplinary task in Geography, History and Science). Everything was linked.

Apart from clear differences being highlighted in classroom management and expectations, two things that Cornelius said caught my attention.

1. "it's like normal learning"
2. "It also came in History ... especially the Atlantis"

I wonder what "normal" is and if it is a good thing. I suppose I should have asked at the time, but it certainly has got me thinking now. And that reminds me of what our students have become in my school context. They have become catalysts for reflection in that things they say (IF listened to) can lead to significant change at a classroom and school level. The most striking example of this was the Cantwell *challenge* which was essentially, "Well that's all very nice, but it's not what the assessment shows you value". This led to broad school-wide changes in assessment. Cornelius' challenge is for me to ask myself "*is my class normal and is this a good thing?"*

The reference Cornelius made to his studies in History was to some extent a validation of the work staff had done in trying to find ways to teach our *disciplines* rather than our *subjects*. In our middle-school, this is a deliberate focus of History and Science, but also of Geography. Other areas may teach aspects of their discipline, but this may be more accidental than deliberate. The importance of this is shown in this extract;

> disciplinary perspectives differ in the ways that they structure, produce, and validate knowledge, and that in such differences... individuals can come to think in qualitatively new ways or discover the solution to a problem unlocked by the insights housed in a neighboring domain. (Miller, 2004)

In this regard, Cornelius is providing a reminder of the importance to teach the discipline and how perceptive students can be in recognizing the differences. We need to be disposed to take notice of those reminders. Perhaps what the boys are showing us is that it is the subject content that is slippery but disciplinary knowledge is not.

Stake out #2

I spoke to two more former students, both in their final year and both studying one of the sciences. They recalled easily different items of knowledge from their junior years.

Michael sees that his classes now are less interactive and that they are less accountable.

> "… we used to go up to the board and ... we'd do theory of stuff ... most classes and then we'd do some ... practical work ... but ... yeah it just seemed like ... it was ... you were more encouraged to engage in the class than you are now like ... to ask questions and stuff. That's one good thing ... that I sort of took from it, to ... not be afraid to ask a question if you don't understand something. [Now] you do see some kids who just ... suffer silently ..."

Nick was asked about classroom structure. The intention of the question was to explore the impact of the *cultural force* of *environment* (Ritchhart, 2002). He interpreted it differently; he looked at this how the classes were managed. A sloppy question on my part, but it gave an interesting response.

> Nick - You'd always get us to write stuff, you'd always get us to like brainstorm when we first did stuff … But now we sort of just get given the notes... Yours was a bit more ... interactive.
>
> *Me - Which class do you think helps you develop the characteristics you listed previously? (Reflect upon the possible difference between being a scientist and a student of Science)*

Nick - I think ... definitely ... in senior school you've sort of just ... you've got to find something and that's all you're looking for, but ... I think this one [Middle-school??] we were just trying new stuff, so that's curious.

So both boys seemed aware of the differences in how their former and current Science classrooms were run, but they were not critical of either. They accepted that their current studies had different external pressures which placed a focus on content, and like Jeremy they seemed comfortable with the certainty that seemed to give.

Nick captured some of this:

Me - Do you feel like you're doing Science now or are you doing Chem?

Nick - I'm doing Chem.

Me - And what sort of Chem? … School chem or "real" chem?

Nick - I think there's hints of real chem in there but it's sort of like the basis of school chem.

Me -In Y11, did you do school chem or real chem?

Nick - I think sometimes we did real chem because our teacher was ... a scientist. He was an inventor himself …

I wonder why it is that these two boys in particular chose to attempt chemistry at the senior levels when they freely acknowledged that they did not achieve spectacular results in their earlier years. Nick detailed some of his academic *journey*.

Nick - I enjoyed Science in Y7 and 8. I thought ... ummm ... it was a good way to get into it, I guess. Like, the prac, a lot of pracs and stuff... I wasn't very good at it back then … I didn't pay attention much.

Me - When you went into Y9 were you disposed to do Science?

Nick - I started paying attention and I realised I liked it, so I sort of got into it and decided I wanted to do Chemistry in Y11. ... [I] used to not like science, but now I do. But, I think that's just because I pay attention now and understand it. When you understand something …

Me - Do you know why you didn't like it though?

Nick - 'cause I didn't understand it. 'cause I didn't pay attention so it was all sort of like this cycle

Me - Now, do you know why you didn't pay attention?

Nick - Umm, it's probably my work ethic.

Me - We're not examining you ... if you showed no interest ... I'm wondering, was it content. Was it the stuff we did? Was it the way I did it? ...

Nick - I think I was a bit immature in the early stages.

And so he should be! I would like to think that Nick's responses highlight the value of having a robust and flexible curriculum structure in his earlier secondary years that focusses on deep understanding of a few important concepts (not content), that focuses on skills necessary for later years and focusses on the discipline (not the subject). He may also be reminding us of the gift a discrete middle school delivers to its teachers, in that it is a place that allows teachers to explore topics deeply, a place to teach their discipline and which is a place that is relatively free from the demands of external assessments. Having said that, teachers in such a place need to understand its special demands. Understand that they have the challenge of moving students away from a primary school environment to a senior setting that has a greater emphasis on independence. Understand that the students they are teaching are undergoing significant physical, emotional and cognitive changes. Understand that it is a unique environment, not a diluted version of the upper-secondary structure. My former students have reminded me of these things.

So what does this tell me about the boys I used to teach?

I am deeply aware that these boys may have softened their responses to the questions because I was the one asking them. However, I would like to believe that their responses did reveal a few things about themselves and how they saw their own development.

All boys seemed aware of the difference in focus on content between the two levels of the school. They seemed to understand the practical realities of the senior school focus and accepted/embraced this. What is interesting is that they were able to have that conversation. The boys interviewed were aware consumers of the school "product"; that is, the subject content and its

assessment. That they were able to do this suggests they do have some sense of ownership of their own learning.

Reflecting on how they were and what they have become, they were able to show they understood how they were developing. The senior boys in particular had a clear perception of how their particular developmental stages affected their performance and they (rightly or wrongly) accepted that. For teachers this reminds us that our students are growing in many ways and we must remain mindful of that. Looking at what our students can become rather than focusing on what they are allows us to cultivate that potential.

The boys did not find it strange that a science teacher was writing an essay. Who knows if their exposure in middle school to opportunities to display *transfer* was a factor, or that they recognized that this is just another way of collecting data to test a hypothesis? What is clear is that these students were willing to engage in a conversation about teaching and learning. These boys have the ability to reflect on my practice (and theirs) and in many, many ways they are better placed to do so. Surely this is true for all teachers. We can only guess what it is like to be a student in our classes. It makes sense to ask the experts if we really want to know, if we really care about how we want our students to interpret the time we spend together.

At a personal level the boys continue to remind me of the need to challenge my practice. Their responses emphasise how important it is for me to have a clear vision of what understandings should endure – arguments (or *robust discussions*) with other students is not one of them. For the boys to whom I spoke, I hope that what continues to stick is to be able to clearly differentiate between *subject* and *discipline*, and that they can teach their teachers.

Mark Coleman has been in the class room for 29 years. He has taught Physics, Mathematics and Science at all levels from year 7 – 12. For the last 11 years he has been Science teacher of 12 – 14 year old boys. This latter period of his career has enabled him to study his students closely. The result has been that he has developed clearer views on the education of boys in this age group, through careful study of his students and reflection upon his work practices.

 © Mark Coleman, 2012