Students' attitudes to practical work by age and subject

Rachael Sharpe

Abstract

This article reports on a study into students' attitudes to practical work. The findings suggest that students' attitudes differ according to their age and the particular science where the practical work is conducted. The implication is that teachers should be more aware of how students' attitudes to practical work change as lessons move further away from a focus on the enjoyment of science towards one that is examination-orientated. Simply doing the same amount of, and adopting the same approach to, practical work is unlikely to foster positive student attitudes towards practical work in all three sciences.

Keywords: Practical work, students' attitudes

Background

Few can doubt that practical work plays an essential role in biology, chemistry and physics lessons within secondary schools in England or elsewhere. Practical work refers here to any science teaching and learning activity which involves students, working individually or in small groups, manipulating and/or observing real objects and materials, as opposed to the virtual world (Science Community Representing Education (SCORE), 2008). Students often ask their teacher upon entering the laboratory if the lesson will involve practical work and the fact that many science lessons are in a laboratory, as opposed to a classroom, may, in fact, be part of the answer as to why practical work is often carried out (Nott, 1997). Furthermore, many teachers claim that students enjoy doing practical work and that it motivates them, and teachers see those two reasons as being sufficient justification in themselves for carrying it out in their lessons (Abrahams and Sharpe, 2010). Yet with the amount of practical work being carried out in schools, which in the UK is higher than in many other countries (SCORE, 2008), it raises the question as to whether students' attitudes to practical work are the same in each of the three traditional sciences and whether these change according to their age.

An 'attitude' problem

In order to understand students' attitudes to practical work, it is important to define what is meant by the term 'attitude'. In this article, following Haddock and Zanna (1999), attitudes are taken to be "overall evaluations of objects that are derived from three general sources of information: (a) cognitive, (b) affective, and (c) behavioral" (p. 77). By exploring each of the three components separately it is possible to form an overview of a student's overall attitude. Of these three domains the cognitive domain relates to a student's beliefs or thoughts about something, such as when a student expresses their belief that practical work is a useful tool in learning science. The affective domain relates to a student's feelings or emotions about something as, for example, when a student may highlight that practical work makes him or her feel happy in, or enjoy, science. Finally, the behavioural domain refers to a student's past and/or future behaviours with respect to something as, for example, when a student may start to participate in more practical work lessons, clubs or do more than is expected in a practical work lesson. Therefore by investigating students' verbal comments and non-verbal communications in terms of these three domains it is possible to explore their overall attitude to practical work. Figure 1 illustrates how the verbal statements within these three categories can be used to infer a student's attitude to a stimulus, such as practical work.

[INSERT FIGURE 1]

Research strategy

This article presents the findings from a study that investigated students' attitudes to practical work in biology, chemistry and physics. The study involved 607 students, aged between 11 and 15, from three secondary schools in England. Data were collected using questionnaires, audio-recorded lesson observations with semi-structured interviews with students during the lesson, and focus groups with students after the lesson. All names of schools and students are pseudonyms in order to ensure anonymity. Throughout the article a coding system is used in which each of the three schools will be referred to as 'School L', 'School N' and 'School B' with the teacher observed in each school referred to as 'Teacher L', 'Teacher N' and 'Teacher B' respectively. When referring to students' quotations, a pseudonym is used that begins with

the letter for the school followed by the year group number (7, 8, 9 or 10). For example, a comment coded 'Larry 9' would refer to that made by a male student from School L (names used reflect a student's gender) in Year 9.

[INSERT TABLE 1]

The three secondary schools were drawn from a convenience sample and were selected to provide what Ball (1984) refers to as "naturalistic coverage" (p.75), that is they were considered to be broadly representative of schools from within the population from which they were drawn in terms of size and geographical setting.

Students' attitudes to practical work: A general overview

The findings suggested that students' attitudes to practical work often fall under the three areas of an attitude – cognitive, affective and behavioural – and that the most significant of these were found to lie in the cognitive and affective domains.

Within the cognitive domain students discussed how they felt that practical work enabled them to see phenomena for themselves and that by seeing it for themselves they were better able to understand the theory. Whilst some students claimed they needed practical work to learn, others mentioned their concerns that practical work might give them the wrong answers which, they felt, could have implications for their learning for examinations.

Findings within the affective component suggested that whilst most students claimed that practical work was their favourite part of science lessons this was more an expression of their *preference* for practical work over other types of teaching science than about a real liking of practical work. Whilst many students claimed to enjoy the 'hands-on' aspects of practical work, there were others who claimed to prefer the non-practical activities. Students also showed feelings regarding personal autonomy in practical work and the implication that this depended on the openness of the aims and purposes of what they were doing.

Students' comments within the behavioural domain tended to focus on the opportunity that practical group work gave them to talk and work with their friends, rather than what they were actually learning about during that practical lesson. Some students commented on the behavioural issues of other students in their classes impacting either positively or negatively on their enjoyment of the practical lesson. Also, some students spoke of the impact of practical work on their choice of career and its application to real world science, including the claim that they were able to learn practical skills. However, amongst many of the students there was a widespread perception that whilst practical work was important, it was not relevant to them as they had little, if any, intention to continue with a science after compulsory education.

Age-related attitudes

One key finding from this study was that students' attitudes to practical work were age-related and that they declined as they progressed from Year 7 through to Year 10. Whilst in Year 7 students come to their science lessons showing much enthusiasm in the aspiration of carrying out practical work, by Year 10 this had diminished with a growing realisation of both their need to learn the 'theory' for examinations and the fact that they were coming to the end of compulsory education and for some students, the start of choosing their A-levels.

Within Year 7, students' attitudes to practical work related mainly to the affective domain and essentially involved "'absolute' claims" (Abrahams, 2009, p.2342) in the sense that they claimed to enjoy and learn from doing practical work in biology, chemistry or physics lessons in an objective sense. Year 7 students commented on how practical work was particularly useful in enabling them to learn and remember as the following representative quotes illustrate:

> Bette 7: When you see things and you do it yourself you remember, but when you just write it down you forget. So like you learn more when you're actually doing stuff.

> Bethany 7: He [Teacher B] showed us them so we could like get an idea of what they actually look like instead of like seeing them in cartoon and like seeing pictures of them, because if we didn't see them straight up in front of us we wouldn't have a good … We wouldn't be able to remember it really well.

Some Year 7 students explained how they were able to learn from practical work in all three sciences because they were able to see the phenomena and learn how to use scientific equipment. They felt that it was an enjoyable part of their science lessons and that it not only motivated and interested them but was their preferred method of learning as shown in the comment below:

> Ben 7: We looked at sheep cells under the microscope so we learnt about what the cells looked like and how different they were; mine looked like a sweet potato! But like we wouldn't learn that from a book.

However, by Year 9, students began to convey a rather mixed message. Students' attitudes began to be dominated less by the affective domain and more by cognitive issues. Compared to Year 7 students, Year 9 students began to be more critical about what they were actually able to learn from doing practical work as opposed to *assuming* they would always learn because they were enjoying *doing* practical work, illustrated in the comments below:

> Leah 9: ... and then because we haven't written everything down or we haven't finished the practical, we haven't cleaned up in time, we have to stay in during our break to clean it up and stuff ... then we don't know the answers for our exams! I mean where's the learning in that? I need to pass my exams so practicals are useless then.

> Luke 9: I can do practical work if I'm given the instructions as to what I've got to do. Sometimes I think you get given an experiment and they don't explain it fully and then you go wrong and then the teacher [Teacher L] will like blame you because you haven't paid attention. But if they don't give us clear instructions about what to do you just don't get it or understand as much.

What became apparent is how by Year 9, as Leanne and Lucas explain, whilst practical work was still being seen as useful, there was a growing perception about the potential difficulties associated with the over or under use of it:

Leanne 9: I think we need half and half because like … I mean, our exams are mostly written so we need to know the written science and we could put the practical science into our written science.

Lucas 9: I think that … like somebody said earlier, I think that without the practical the written work wouldn't work properly and then without the written work the practical wouldn't like work. Because it's like they're both helping each other, and helping us to then understand.

By the time students reached Year 10 their attitudes towards practical work were found to have become more critical. Indeed, some students openly questioned the value of practical work in terms of helping to develop their conceptual understanding which, due to the pressures of approaching GCSE examinations, was becoming particularly relevant to them at this stage in their education, as the following comments exemplify:

Nicola 10: Practical work doesn't help me when I'm sitting my science in the hall. It doesn't tell me the answers; the theory helps us with that.

Nancy 10: Sometimes the practical goes wrong but we don't know it has and so we get the wrong answer not knowingly and then we learn the wrong answers, so the book telling us the answer is better.

Overall, Year 7 students were found to feel positive towards practical work in biology, chemistry and physics. What they seem to believe is that because they enjoyed it and felt they could get hands on with the equipment, they would therefore be *learning.* In this year group a student would say they liked practical work primarily because of an affective reason, such as it was fun, as has been previously reported by Abrahams (2009). This affective reason would then be followed by a cognitive or behavioural reason, or indeed both. However, by Year 10, students were less positive about practical work in all three sciences and their reasons related more to the cognitive than the affective domain. Whilst their attitudes referred to *preferring* practical work, they were more concerned with issues relating to the ability to learn from it.

The subject difference

Alongside the impact that age played on students' attitudes to practical work, the particular science – biology, chemistry or physics – also influenced their attitudes. In this study it was found that students' attitudes to practical work in the three sciences differed within each year group. Students' attitudes to practical work were very positive in Year 7 across all three sciences with affective responses involving 'absolute' claims. By Year 9, students' attitudes to practical work in physics remained positive but reasons for enjoyment related to the cognitive domain. By Year 10, students' attitudes were significantly lower for practical work in physics compared to Year 7 and Year 9 with the cognitive value of practical work being an important factor in shaping their attitudes.

Attitudes to biology practical work were relatively stable as students progressed through their secondary schooling. Indeed, whilst practical work was not seen as a *favourite* part in biology lessons, it remained an enjoyable part of biology as they aged. Students commented on preferring practical work in biology over chemistry or physics because it was easy and was seen to have more relevance to their own lives. As the following comment suggests, biology

practical work was a useful tool for aiding learning and recollection of information because of the application and relevance to their lives:

> Belle 7: I dissected a chicken leg with Sir [Teacher B]. I knew about it and had done some other stuff at home about it 'cause it was really... it interested me, so like when my mum broke her leg and the doctor told us about where it was, like, my dad didn't know but because I like knew, I could tell dad about the tendons, the muscles and things ... I found it really interesting.

Students' attitudes to practical work in chemistry were less constant than for biology and the differences across the year groups were mainly within the affective domain and the relevance of it. Chemistry practical work was more favoured than biology practical work, especially in Key Stage 3, although not as favoured as physics. Students explained how being able to 'see' some science phenomena occur enabled them to learn – although this learning tended to relate primarily to a recollection of what happened as opposed to understanding the actual scientific concepts, as the following statements exemplify:

> Leanne 9: In [Teacher L's] class she had this like pot of … I don't know what it was. And she put a substance in it and it just went black in like two seconds.
> Researcher: Why did it do that?
> Leanne 9: I'm not sure, I guess it burnt.

> Nathan 10: It is useful to remember what happens, like with the jelly baby practical because we saw it happen there and then.

However, students were aware that sometimes in chemistry practical work what was meant to be seen or learnt was often less than clear due to the distraction of what have been referred to as "'whiz', 'bang', 'pops'" (Abrahams, 2009, p.14), as the following two students explained:

> Lara 9: In chemistry practicals I am so confused with all the things that are going on, the flashes, the smells, the colour changes that I am unsure what it is I need to remember!

> Lacy 9: We burnt something and the flame was green, not sure why it went green, guess it was something to do with oxygen but it was a really pretty green.

Within physics, students (in Year 7) gave positive affective and cognitive arguments for their enjoyment of practical work; however, by Year 10 their attitudes had declined and their reasons were predominantly within the cognitive domain. In comments made by Year 9 and Year 10 students, physics practical work was seen as making the subject a little more accessible than was the case in biology (and presumably chemistry but this was not explicitly mentioned) as the following comments illustrate:

> Lisa 9: I think it would be good to do more practical work.
> Researcher: In all your sciences?
> Lisa 9: Well not so much biology, but maybe chemistry and definitely physics as that can be hard without practical work.

However, when students were asked to explain in more detail what they had learnt during a specific piece of practical work in physics it became evident that far from practical work helping them to understand the underlying scientific concepts, it merely enabled them to describe what they had done or what had happened, as the following comments demonstrate:

> Nikki 10: Well, there was a practical we did with power packs and the lad kept turning the lights off.
> Researcher: What did you learn?
> Nikki 10: I'm not sure, but we were bending the light with prisms and stuff.

In Year 9, students' attitudes to practical work differed between the sciences primarily within the cognitive domain. Students' comments showed that they had begun to feel that the potential learning and understanding opportunities from practical work in physics were greater than in chemistry and particularly more than in biology, as illustrated in the following comment:

> Lesley 9: Well, it is fun and, well, like in physics, it helps us learn quite a lot because you can see the stuff happening instead of just seeing it in a textbook.

Interestingly, in Year 9 not only was biology practical work not seen as being the preferred option over non-practical work but there was also a more critical view, compared to physics, about the value of biology practical work as a means of developing their conceptual understanding.

By Year 10, students' maturity has developed in such a way that they showed themselves to be realistic about the benefits and limitations of practical work. In this year group there was a degree of stability in terms of their attitudes to practical work in biology, chemistry and physics. However, there were more students who preferred practical to non-practical work and felt the laboratory made doing practical work easy in chemistry, when compared to physics.

Students' comments suggested that whilst they valued practical work as part of biology, chemistry and physics, it was of little relevance to their lives unless they wanted a career in a particular science subject area as shown in the examples below:

> Natasha 10: I don't mind like … I like practicals in biology. I like dissecting stuff, that interests me and biology's my favourite subject, so I don't mind it then. I just don't like physics work because it just bores me. Like, sticking wires together and just seeing a light bulb, not as good as seeing a heart!
> Researcher: Are you intending to take physics, chemistry, or biology for A level?
> Natasha 10: Well, I want to be a pathologist so I want to take biology but not physics and chemistry.

> Noddy 10: I like to get involved and do things in practical work. I think that is why I like biology. I'm taking it for A-levels because we get to do dissection then and I want to be a vet so it will help me.

Overall what emerged was the fact that students' attitudes to practical work differed according to the science being studied. Whilst the reasons for students' attitudes to practical work in each of the three sciences differed, with regards to the cognitive and behavioural

aspects, affective aspects were referred to in all sciences. As students progress through school, the reasons for liking or not liking practical work in any one science moved from a focus on the affective domain, such as enjoyment of manipulating equipment, to a focus on the cognitive domain, such as what they could or could not learn from doing practical work.

Conclusions and Implications

This article has highlighted the importance of recognising that students' attitudes to practical work are vulnerable to change more than has previously been assumed throughout their secondary education. These changes suggest that it is misleading to think of students' attitudes to practical work in science per se and that instead there needs to be a greater awareness of how attitudes to practical work are subject- and age-related. There were two particular reasons why students' attitudes to practical work in biology, chemistry and physics declined as they progressed through secondary school. First, is the fact that the greater the perceived intellectual challenge the greater students liked the way in which practical work enabled them to escape from the need to think scientifically. Second, students are personally developing and becoming aware of the importance of cognitive issues compared with the affective reasons for enjoying practical work. Hence, by Year 10, where lessons are felt by students to be more driven by GCSE examination requirements, students see practical work as being less effective in their learning than other methods of teaching.

The findings from this study suggest that teachers need to be more aware that practical work generates substantial enthusiasm in all three science subjects at Key Stage 3 but that this enthusiasm declines as students move into and through Key Stage 4. Such an awareness might therefore suggest that having more practical work in Key Stage 3, as a means of further engaging students with school science, might be beneficial, before reducing it below the current amount in Key Stage 4 so as to enable students to focus more effectively on achieving high examination results.

References

Abrahams, I. (2009). Does practical work really motivate? A study of the affective value of practical work in secondary school science. *International Journal of Science Education,* 31 (17), 2335-2353.

Abrahams, I. and Sharpe, R. (2010). Untangling what teachers mean by the motivational value of practical work. *School Science Review,* 92 (339), 111-115.

Ball, S. J. (1984). Beachside reconsidered: Reflections on a methodological apprenticeship. In R. G. Burgess (Ed.), *The research process in educational settings: Ten case studies* (pp. 69-96). Lewes: The Falmer Press.

Haddock, G. and Zanna, M. P. (1999). Cognition, affect, and the prediction of social attitudes. *European Review of Social Psychology,* 10 (1), 75-99.

Nott, M. (1997). Keeping scientists in their place. *School Science Review,* 78 (256), 49-61.

Rosenberg, M. J. and Hovland, C. I (1960). Cognitive, affective, behavioural components of attitudes. In C. I. Hovland and M. J. Rosenberg (Eds.), *Attitude organization and change: An*

analysis of consistency among attitude components (pp. 1-14). New Haven: Yale University Press.

Science Community Representing Education, SCORE. (2008). *Practical work in science: A report and proposal for a strategic framework.* London: Science Community Representing Education (SCORE).

Word count: 3846

Dr Rachael Sharpe is a senior lecturer in science education in the School of Education at the University of Lincoln. Email: rsharpe@lincoln.ac.uk.

Figure 1 A model of the three components of an attitude (taken from "schematic conception of attitudes" Rosenberg & Hovland, 1960, p. 3)

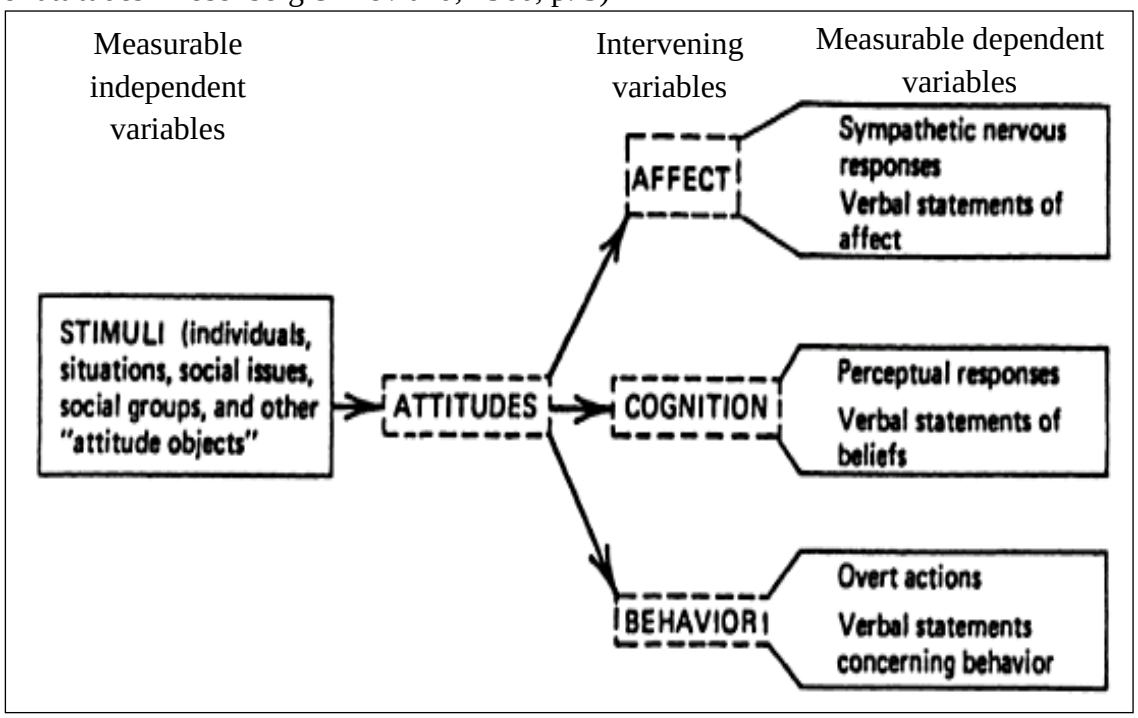

Table 1 School Information

School	Type	Number on roll	Age Range	Education Authority	Science Curriculum at Key Stage 3	Science curriculum at Key Stage 4
School L	Rural secondary modern	600	11-16	1	Collins Science, The CASE	Edexcel, 360 Science Suite
School N	Urban comprehensive school	1400	11-18	2	Oxford University Press, Science Works	OCR, 21st Century Science
School B	Rural comprehensive school	950	11-18	3	Collins Educational, Key Stage 3 Science	OCR, 21st Century Science