That's Science!

When you jump up high you come back down low,
When you fall, you don't always land on your toes.
That's Science!

There's a reason behind everything we do and say,
And we learn more reasons everyday!
That's Science!

Hilary Campbell, 14 years
Australia

Transforming Your Practice: Hero or Heretic

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Abstract

How do you transform your own practice, and the practice of your peers? How do you act as a change agent in a positive, open dialogue with peers? The author seeks to explore this complex, often difficult issue, hoping to encourage others to look at their practice, and the practice of their peers, and ask: "Can we do better?" Can we better engage our students as active learners? Can we improve the teaching and learning process for our students?

Introduction

In this paper, I wish to explore a number of issues exposed by the following extract from a question distributed, by the Editor of this journal on behalf of a teacher, to journal readers:

> My teaching to date has been fairly traditional, although in accord with the overall culture of our school. Lecturing to passive students, for example, is commonplace in the school, and quiet students sitting in straight rows has a long tradition and appears to be valued. However, in accord with current recommendations for science education reform, I am keen to try to introduce some changes in my classes. (P. H. Eastwell, personal communication, August 26, 2004)

I empathise, on a number of levels, with this teacher of Science. I too have worked in schools in which the rationalist belief in the transmission of knowledge was the dominant pedagogical paradigm. I too have sought to change the experience for my students. I too have sought to change the pedagogy of my colleagues.

This quote could well have described much of my experience with science as a student during the 1970s. I made lots of notes from the blackboard, answered lots of questions from text books, and about once a fortnight I completed a practical activity that may, or may not, have made sense of the preceding concepts.

Whitehead (1989) describes the concept of a living educational theory, the product of a systematic reflective process on the nature of how to improve one's personal practice. It has five stages:

1. You identify a problem because some of your educational values are negated.
2. Imagine a solution to the problem.
3. Act in the direction of the solution.
4. Evaluate the outcomes of the solution.
5. Modify your actions and ideas in the light of your evaluations.

Whitehead suggests the starting point for a cycle of one's living educational theory is the question: "How do I improve this process of education here?" This question may be the result of a reflective teacher responding to a challenge from a student, such as: "Why do I have to learn this sh**?" (Blades, 1997), which has certainly been my experience. In other cases, the impetus to question one's pedagogy might stem from reading about other ways to teach science, or hearing about such from teachers in other places.

How can you enhance the classroom environment for your students? Stoll, Fink, and Earl (2003) list the following 10 features of successful teaching and learning that enhance student engagement:

1. Use cooperative learning rather than competitive learning.
2. Stimulate cognitive conflict.
3. Encourage moderate risk taking.
4. Praise good work.
5. Make academic tasks interesting.
6. Provide feedback that is connected to learning and effort.
7. Identify many intelligences, showing that they are not fixed but incremental.
8. Encourage self-images as learners.
9. Increase student self-efficacy.
10. Encourage volition.

These features are not commonly found in the traditional classroom. In my experience, students seated in serried ranks, all working quietly to receive the scientific truth from the teacher, tend not to work cooperatively, are rarely caused to experience cognitive conflict, rarely take risks, are treated often as identical in regard to learner characteristics, and rarely reflect on their own learning. However, a traditionally constructed learning environment need not be void of these features.

Rowe (2003) believes that teachers are the single most important determinant of student success. He believes that quality teachers and teaching, supported by strategic professional development, is what matters most. He claims that what works is the early identification of students at risk, followed by appropriate intervention that deals with their concerns, on-going, strategic, individual-teacher, and whole-school professional development, and a relentless commitment by the whole school community to ensure that success for all students becomes a reality. He believes that this requires the presence of four factors:

1. Well-trained staff.
2. Higher expectations of student outcomes.
3. Structured teaching focused on the learning needs of individual students.
4. Engaged learning time.

According to Rowe (2003), students want teachers who have knowledge and understanding of what they teach, are enthusiastic for their subjects, make student learning the core of what happens in the classroom, treat each student as an individual, manage the distractions that disrupt and prevent learning for students, care for, and are encouraging of, their students, and are fair and just in their interactions with students.

These features of successful teachers and schools are independent of pedagogical approach (Rowe, 2003), but in my experience it is less likely that a teacher who structures a classroom around quiet children sitting in ranks and learning the "facts of science" can be seen to be treating his/her students as individuals. It may also suggest that the teacher has either not questioned his or her practice, or has made a conscious decision to teach in a traditional manner.

Not Alone

So, having decided to change your practice, how do you get started? The first, possibly most important thing to remember is that you are not alone. Many others have struggled, or are struggling, with change and writing about their experiences. Blades (1997) writes of his experience in Canada with the management of curriculum change to better engage students and better suit their perceived needs. Vaille Dawson (Dawson & Taylor, 1997) has struggled with implementing constructivist approaches in her teaching and discovered that different groups of students respond differently to change. Bentley, Fleury, and Garrison (in press) offer an excellent look at how critical constructivism can be used in preparing pre-service teachers. Scharmann, Shroyer, and Cherin (1996) describe how, despite training in student-centred techniques and Science-Technology-Society (STS) themes, trainee teachers on rounds were still unlikely to implement STS approaches with direct instruction due to pressure from supervising teachers and their own discomfit with the STS approach. These are but a few examples of teachers and academics working with approaches that attempt to treat students as individuals and approach scientific knowledge as a constructed form of knowledge.

Another factor to consider if you are to be successful is to ensure that you do not work alone in your school. It is important to find supportive, significant, critical friends (Taylor, 1998) within your school who are able to help you through regular reflective debriefings. If possible, this group of like-minded colleagues might conduct an action research project within the school setting, investigating the effects on student engagement and learning outcomes of changing the dominant pedagogy. For both intellectual and emotional support, I would also recommend enrolling in post-graduate study. The most important benefit of working toward a degree is that you are in touch with recent research and trends in pedagogy and scientific thought, and this provides another group of critical friends from whom to seek support.

Take it Slowly

Humans tend to resist change, especially as we age. Take it slowly with students, other teachers, and your school. As Geelan (2000) writes, when addressing the move from teacher-centred pedagogy to student-centred pedagogy, one can leave an "empty center." He found that having vacated the central position of control, before his students were empowered to assume that central position, left a void. He had moved faster than the students were able to cope with. It is important to set a pace of change that the others can keep up with. The students are less encultured into the way of one's school (maybe this means the earliest year groups in your school are the best place to start) and, being young, are more open to change. The teachers are more set into a way of doing things and, being older, are less open to change. They will require you to prove the value of the change (often over and over again) before they invest the personal energy required to change their

own practice. By talking about your student's successes informally over morning coffee, or formally in meetings, and by having your students present their findings to the school community, it is possible to include more and more of your colleagues in what you are doing.

Heretic

Expect to be seen by some as a heretic. Your attempts to cause change will be attacked by deeply entrenched colleagues unwilling to change. As I found in my attempts to innovate (Simpson, 2005), one of the main impediments to change are the procedures of power at work within the social matrix of the school (Foucault, 1980). Part of that social matrix is the phenomenon of teaching as team game. The school expects that the teachers will act as members of a team, treating students in approximately similar ways to maintain a certain standard of behaviour and a certain standard of achievement.

For many science educators, transmission of important content to students is vitally important. Science teachers tend, by dint of training, to be conservative and to hold a rationalist belief in the existence of an objective truth waiting to be found and the ability of science to find it. This tends to also mean that they believe that they are able to teach these self-evident truths to students, or are at least expected to try. This is not the place to have a conversation about the nature of scientific belief, but when applying constructivism pragmatically to the teaching of children, one needs to understand that students enter the room with views of the information that one wishes to teach that they have constructed for themselves. Before you can successfully reconstruct their knowledge in the direction of scientific understanding, one must undermine their confidence in their own beliefs. For the majority of students, this does not occur simply by telling them facts. I believe that they need to experience the making of scientific knowledge, not just be told about it. This belief is not harmonious with a rationalist approach to the teaching of Science.

The management of students' behaviours is often quoted as being important, with students sitting quietly in class, taking notes, and answering questions seen as productive. Students moving about the room, interacting with each other, and making noise is seen as unproductive. However, does managing their behaviour in this way mean stifling their creativity and engagement with the subject matter at hand? Consider a classroom where students sit facing each other, learning by actively interacting with each other. A classroom where students' work is displayed, students freely move about the room seeking materials and advice from their peers, there is constant chatter about the work at hand (most of the time), and there is lots of student activity as they experiment with new ideas. This is my classroom (Simpson, 2005, in press). My students successfully build cognitive structures, in line with western scientific thought, that they also tend to retain.

Hero

Look forward to being seen as a hero. For many of your students, you will be a hero. You will make their experience of science education fun. They will look forward to your classes. You will have opened up the experience of science to include them, their own constructions, and their own experiences, through purposeful activity.

The traditional pedagogy of teaching and learning has allowed students with linguistic and logical-mathematical intelligences to experience success. It has also privileged students with aural/visual learning skills. What of our kinesthetic learners? What of those with other intelligences; musical, visual-spatial, intrapersonal, interpersonal, or naturalistic? They exist in our classrooms, but we have to change our pedagogical approaches extensively to be inclusive of their needs and to allow them success. Many studies, including my own (Simpson, 2005) have shown that classes in open-

entry, non-selective schools are diverse places. Students need to be treated as individuals, and appreciate it when they are (Stoll, Fink, & Earl, 2003). To these students in particular, you will be a hero. If you are able to influence other teachers to reconsider the manner in which they teach, and they become cognisant of the range existing in their student's characteristics, you will have also gained professional respect from them, as their relationships with their students will greatly improve.

Recommendations

So, after all that, what recommendations can I make? Working as a change agent with both colleagues and students, you need to strive to have all parties consider their deeply-held beliefs about pedagogy, which are based on thousands of hours of encultured experience, and find those beliefs to be without foundation for our new millennium. Probably, at best, you can cause a pedagogical thoughtfulness in others, if they find that your experiences resonate with theirs (Geelan & Taylor, 2001). The following steps may be useful:

Step 1. Enrol in post-graduate study. This will expose you to many writings on the subject of alternative pedagogies and link you with like-minded educators outside your school from whom you can receive moral and emotional support (and there are times you will need both!)

Step 2. Set up an action research project with like-minded colleagues that seeks to display how your pedagogy can more fully engage the diversity of students in your care and enhance their educational outcomes. It is important to have critical friends within your workplace from whom to gain support and with whom to share ideas and reflect on experiences. Make sure that you have the permission of the school leadership to carry out your research.

Step 3. Take it slowly. You are trying to change the manner in which your colleagues view the nature of truth in science and how scientific truth can best be taught. You may be asking them to give up a rationalist belief and to replace it with a neo-relativist belief in the nature of scientific truth (Simpson, 2004) for the sake of the next generation of adults operating in our society, some of whom will use scientific knowledge, or its application, in their daily lives.

Step 4. Share your and your students' outcomes and experiences within the school community and within the wider education community. You are about to become a risk taker, and things won't always work, but you must share both the successes and the failures to help you and your colleagues reflect on your experiences and those of your students. Your experiences need to be shared with other educators; you may be responsible for someone else becoming a hero (or heretic).

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Students' Alternative Conceptions

Students' alternative conceptions have been variously called misconceptions, prior conceptions, preconceptions, preinstructional beliefs, alternative frameworks, naive theories, intuitive ideas, untutored beliefs, and children's science. The tasks in this regular section of *SER* are based on the literature and may be used at the beginning of a constructivist learning segment to arouse the curiosity of students and to motivate them, while simultaneously eliciting their ideas or beliefs. They are designed to address areas about which students are likely to have an opinion, based on personal experiences and/or social interactions, prior to a specialist learning sequence, or areas that might be considered important for the development of scientific literacy.

Weight of a Candle

A candle is placed on a balance and lit. What happens to the balance reading as the candle burns?

(a) No change, because the candle just melts.
(b) No change, because the candle changes shape but not mass.
(c) No change, because the weight of the flame does not change.
(d) Increases, because the burning candle combines with oxygen from the air.
(e) I have a better idea. Please explain.

Comment: The mass of the candle will decrease--Choice (e). The candle wax is used up because it reacts with oxygen in the air to produce gases (carbon dioxide and water) that move into the air. Also, some unburnt carbon from the wax (i.e., the smoke) will also move into the air.

Source: Calik, M., & Ayas, A. (2005). A comparison of level of understanding of eighth-grade students and science student teachers related to selected chemistry concepts. *Journal of Research in Science Teaching*, *42*, 638-667.