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CONTENTS

CONSTRUCTING SCIENCE EDUCATION

There have been many interesting proposals in the science educational literature about how we should modify our methodology of science teaching and learning. From this point of view it's interesting to examine briefly the topic of constructivism in science education.

It seems to me that constructivism in some form is the only way that, at a conscious and reflective level, we human beings can learn and begin to understand and make sense of the world in which we live and thus I believe it has considerable significance for science education and for education in general. However, it does not provide simple answers to how we should teach and learn – but there are some important clues as to principles we should try to follow and to where many formal education systems may be at fault.

There are numerous flavours of constructivism: Piagetian constructivism; Ausubelian constructivism; Social constructivism; Radical constructivism and, doubtless, constructivism could be attached to the names of other famous educational names too, such as BRUNER, GAGNÉ, VYGOTSKY, GARDNER etc. Even if I were competent to explain, expand on these 'constructivists' here would not be the place to do so. In fact I like the 'boat metaphor' that leads to the rather fluid image of constructivism (of learning and of scientific ideas) that is taken from (PUTNAM; 1981, p. 118) and quoted in NIAZ; 2003).

"My image is not of a single boat but of a **fleet** of boats. The people in each boat are trying to reconstruct their own boat without modifying it so much at anyone time that the boat sinks… …In addition people are passing supplies and tools from one boat to another and shouting advice and encouragement (or discouragement) to each other. Finally, people sometimes decide they do not like the boat they are in and move to a different boat altogether. And sometimes a boat sinks or is abandoned. It is all a bit chaotic; but since it is a fleet, no one is ever totally out of signalling distance from all the other boats."

A key thing that we have to remember (and it is something that those who organise and control the educational system seem not to realise) is that this slightly chaotic image of changing and developing knowledge and understanding applies to all of us – **teachers as well as students**. There often seems to be an expectation that teachers should know everything that they hope their students will learn – and that if teachers make mistakes then they did not prepare their lessons properly or were badly trained. A major problem in this viewpoint is that teachers become reluctant to share their learning with others (their peers, their superiors or their students). It is, of course, a professional requirement that teachers 'know their subject' and prepare their lessons thoroughly but 'the boat they have built for themselves' is continually changing. It could never have been perfect when they qualified – and the knowledge and understandings of the scientific community, and the knowledge and skills required to address the local and global issues of the day are continually changing. These changes together with the fact that we all construct our own webs-of-meaning and critically re-examine and revise these webs continually as we learn more. Consequently in every teaching/learning situation there is some uncertainty. I believe this is important and necessary for effective learning to take place and I addressed some of the values of *an appropriate level or uncertainty* in an earlier paper in this journal (GOODWIN; 2004).

Some of the consequences are as follows:

- Teachers, text-books, internet sources and all authorities have to be recognised as being fallible. Learners are required to critically examine what they are taught and need to be convinced that it makes sense. (In reality of course we all take much information 'on trust' but we need to realise the risks we are taking when we do this. The risk is less if the source is 'trustworthy' and if the information is not centrally significant to our lives).
- Teachers can learn from their students. This *is* legitimate and does wonders for the self esteem of the students. Students have certainly taught me a good deal, by asking 'difficult' questions, by pointing out inconsistencies in my teaching and by sharing information and experiences that I had not received myself. Students also learn from one another.
- Students are encouraged to become more active learners when they know they can contribute – and that the contributions are valued.
- The meanings of words are also constructed. We can probably all use the basic vocabulary of our language in ways that convey meanings relatively unambiguously to others. In science this is not always the case. If I use the words 'chemical reaction' or 'atom' or 'force' there is a range of meanings and multiple layers of interconnections of meanings within these concepts, but I use the words intending *my meanings* to be transferred. When another hears my words they are received with his/her meanings attached. A trivial example of this is that when I was at school the chemistry teacher used the words 'conical flask' but I heard the words 'comical flask' since this made perfect sense to me and the flask did seem to be a funny shape. It was about three years later that I realised that the word 'conical' referred to a 'cone shape' and was able to change my conception. The point at issue is that words can be transferred fairly easily – sometimes with minor errors – but meanings have to be worked at, explored, negotiated and will always be subject to change or development.

We all have to construct meaning. Unless the meanings make sense, are significant to us and can be seen to be interesting and/or useful then it is unlikely that we shall learn. If we do learn meaningless material then it will soon be forgotten.

Constructivism, in most of its flavours, seems to me to provide useful perspectives on the way I learn. It is much more difficult to specify how this affects teaching although others have had valiant attempts at this. Two recent examples that I am aware of are (SELLEY: 1999 and PARKINSON: 2002). Crucial to any learning is motivation and interest – perhaps the most valuable thing a science teacher can do is to demonstrate enthusiasm for learning science. He/she needs to know a lot of science but most importantly needs to enjoy learning and teaching it *with* his/her students.

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