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*Constructivist Science Teacher Education*

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## *Introduction*

A great deal has been written in recent years about constructivist learning theories and their applications to secondary science classroom. Much less has been said about the implications of these ideas and practices for teacher education. Constructivist teacher education is defined as working with prospective teachers in a constructivist way, helping them to re-examine and reflect about the tacit ideas they bring to their education for teaching. Constructivism can be a lens through which we can understand the process of learning to teach.

One cannot think of constructivist teaching, however, as a monolithic, agreed-upon concept. Constructivism is a learning or meaning-making theory. It suggests that individuals create their own new understandings, based upon the interaction of what they already know and believe, and the phenomena or ideas with which they come in contact. Constructivism is a descriptive theory of learning (this is a way people learn or develop); it is not a prescriptive theory of learning (this is a way people should learn). Teacher educators are attempting to develop a constructivist teacher education programme.

Two quite different forms of constructivist teacher education are being advocated today. One form attempts to teach students how to teach in a particular constructivist manner (for example, Black and Ammon, 1992). Often these approaches apply to the teaching of particular subject matters (Mosenthal and Ball, 1992; Schifter and Simon, 1992). Another form of constructivist teacher education involves working with prospective science teachers to help them to understand their own tacit understandings, how these have developed, and the effects of these understandings on their actions; and to introduce new conceptions and premises as potential alternatives to those held by students (Harrington, 1995; Richardson, 1992, 1994). The first form often involves considerable direct instruction in theory and practice. The second attempts to model a manner of involving students in investigations of premises and perspectives that it is thought may be used by the preservice teachers when they begin to teach.

Both forms of constructivist teacher education could present problems. When the teacher educator directly instructs teacher science education students in constructivist theory and has in mind a particular approach to teaching, he or she models an approach to teaching that is contrary to the one that is hoped the students will employ when they are teaching. On the other hand, the second form – the investigation of beliefs and presentation of alternative conceptions of teaching – models an approach to constructivist teaching that may not be appropriate for the teaching of science subject matters.

The challenge for constructivist teacher educators is to develop an approach to teaching that does not contradict the content of the course – that is, constructivist teaching – but acknowledges differences in the nature of constructivist teaching depending on the science content that is being taught. If we engage preservice teachers in process of knowledge construction, we have an obligation to prepare them to work toward the changes necessary to allow them to incorporate these practices in their future classrooms.

In science teacher education knowledge construction is crucial; teacher educators must be able to teach in a manner that models the attitudes and behaviours that they would like their preservice teachers to manifest in future classrooms. Pedagogical approaches derived from constructivism should begin with the content that:

- Foregrounds cognitive development based on merging academic and everyday concepts;
- Defines knowledge as partial and positional;
- Stress critical analysis and reflection.

### *Needs of Prospective Science Teachers*

In this part we develop our ideas in the context of the needs of science teacher education. This invites the philosophy of science as a special informant about the nature of constructivism. We understand a central tenet of constructivism to be what philosophers of science have argued for decades – that facts and processes of observation are theory laden and, therefore, cannot be taken as self-evident in the classroom. Much of scientific knowledge consists not merely of the phenomena of nature, but also of constructs advanced by the scientific community to interpret and explain nature. A constructivist perspective on meaning-making is useful if it develops in individuals a disposition for inquiring into problems.

Science teacher education students need opportunities for testing, discussing, and comparing various perspectives and approaching to teaching. Science teachers become more responsible for their pedagogical choices. Students continually construct meaning of classroom events based on their prior understandings and experiences. It follows that a constructivist science teacher will have a disposition for attempting to see science classroom phenomena from students' perspectives in the instructional programme. The disposition and ability to see from students' points of view is fundamental to sorting out what is right about their thinking as well as what is inconsistent or incoherent about it. To see a phenomenon from a student's point of view requires reconstruction on the part of teacher. The phenomenon in question must be seen in a new light. A critical aspect of science teaching is a teacher's ability to see how such perceptions arise from student's perspectives. We appreciate the difficulty of imparting constructivist orientation to science teacher education students. They often appear to us as discovery learning teachers, with hand constructivist-on activities related to the science idea.

Constructivist talk seems to evoke in some teacher education students a distorted image, or a truncated version, of constructivist teaching. In some representations by students, constructivism sounds like a recipe, a procedure of teaching. In many cases the constructivism looks like discovery learning, when children put forward their science ideas at discoveries, and the cross-checking and testing of those ideas with other references (peers, teacher's scientific knowledge) is omitted.

Science teachers need to concern themselves with the manner in which hear or read constructivism but also the ways in which they represent it to themselves as researchers. Constructivism is a way of thinking about the events of teaching and learning.

### *Summary*

1. Initial knowledge is fragmentary and unstable. Candidates often denote concepts in ways that suggest they think about them in functional or operational terms. Science teacher students need to integrate new professional learnings with their knowledge.

2. Structural knowledge increases over the course of science preservice teacher education, and continues to increase with teaching experience.
3. Knowledge growth is uneven and idiosyncratic. The variation and turbulence in knowledge growth is displayed by beginning teachers.
4. Cognitive structure of student is correlated with the ability to reflect deeply about teaching. Reflection should be a part of science teacher training.
5. Teaching practice is an important part of science teacher training. Student teaching provides such an environment as university classes cannot do.
6. Some science teacher students have misconceptions about science teaching and learning. Students have the needs to directly challenge these misconceptions. Understanding of candidate's prior knowledge is a key to improving science teacher education. Prior knowledge is central to constructivism.
7. Students need better tools in the courses (concept mapping, journaling, biography, research, cooperative work, experimenting, hands-on activities, questioning, discussion, learning by doing, ...).
8. Students need to encourage reflection on previously held views of science teaching and learning.
9. Students need to promote an understanding of a constructivist perspective on learning and its implication for teaching.
10. Students need to understand the prospects and problems of implementing a constructivist-based approaches for promoting changes in science teaching and learning.

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