Developing Student Teachers' Conception of Good Science Teaching Prior to Formal Teacher Education

Objectives

Recent advances in video technologies have led to increasing incorporation of videos into teacher education (Hewitt *et al*. 2003; Sherin, 2004; van den Berg, 2001). Videos have the unique power of capturing and conveying the complexity and subtlety of classroom teaching, with a richness and immediacy that print materials cannot match. They are now increasingly being used, commonly for demonstration of good practices or as a reflection tool for teacher professional development (Brophy, 2004). The study reported here is part of a larger study of a curriculum innovation carried out by a group of science educators in their teacher education programme. The innovation aims to probe, develop and enrich student teachers' conception of good science teaching at different stages of their programme through the use of classroom videos of exemplary science teaching.

A major feature of the innovation is that two weeks prior to the commencement of our programme, we provided our student teachers with a CD-ROM of two exemplary lessons to view at home as a means of facilitating their self reflection on and reconstruction of their conceptions of good science teaching. In this paper, we shall report on the effectiveness of using videos of exemplary teaching in developing student teachers' conception of good science teaching prior to their receiving of any formal instruction from a teacher education programme.

Theoretical perspectives

The process of constructing conceptions of teaching and learning has been compared to the process of conceptual change in learning science (e.g. Abell *et al*. 1998). Gow and Kember (1993), on the basis of research in university teaching, made the point that altering conceptions of teaching and learning is not a task to be underestimated, a finding echoed by Boulton-Lewis *et al*. (2001) in their study of secondary school teachers. Extensive research over the past 20-25 years has shown that students coming into the science classroom often possess preconceptions about natural phenomena, many of which are in conflict with accepted scientific concepts and highly resistant to changes, even after formal instruction (e.g. Driver *et al*. 1985). Posner *et al*. (1982) argue that conceptual change will only occur when students feel dissatisfied with their current conceptions and have access to alternatives which they perceive as intelligible, plausible, and fruitful. It is important, therefore, for science teachers to begin by identifying the preconceptions of their students. Similarly, student teachers begin programmes of teacher education with preconceptions about teaching and learning which is also highly resistant to changes (Duit and Treagust, 2003). Thus their teacher educators need to be aware of these preconceptions and to respond appropriately to them, and they need to be cognizant of how conceptions of good science teaching can be influenced by well-chosen educational experiences.

Methodology

Student teachers enrolled in our programme came for a briefing session two weeks before the course formally began. They were briefed on the aims of the curriculum innovation – to allow student teachers and faculty to better understand and monitor their conceptions of good science teaching at different stages of the course, and to help student teachers to become reflective practitioners. They were then asked to identify features of what they consider to be good science

teaching by filling in a task sheet (Task 1). This data set constitutes their 'pre-video entry conception'.

Each student teacher was then given a CD-ROM with videos of two exemplary science lessons. They were asked to review the videos at home and to identify both the good features of the lessons and areas requiring improvement by completing another task sheet (Task 2). In order not to bias their views, they were told that the videos were just two 'ordinary science lessons'

The two lessons were used because they demonstrated numerous good science teaching elements, it proved however impossible to cover every good feature within the confines of the videos. To address this limitation, the student teachers were also asked to list other essential features of good science teaching that were not exhibited in the videos. Data elicited in Task 2 represent student teachers' 'post-video entry conception'.

The features of good science teaching listed by the student teachers in Task 1 and Task 2 were then counted and classified into categories. The classification was first carried out by the four authors individually, then checked and agreed collaboratively amongst all authors in a reiterative manner.

Based on the above analysis, 42 (out of 85) of the student teachers were selected for an individual interview before the programme began. The selection criteria, amongst others, included student teachers with conceptions of good science teaching ranging from the least sophisticated to the most elaborated. They were asked to elaborate on their conception of good science teaching and, when necessary, to clarify what had been written down in their Tasks 1 and 2, and how the videos have influenced their conceptions. The interview data were transcribed for subsequent content analysis.

Results and findings

A comparison of Tasks 1 and 2 reveals a significant growth in student teachers' conception of good science teaching both quantitatively (i.e. from an average of 8 features per student to 18 features per student) and qualitatively (i.e. to a more diverse range of features). Features of good science teaching frequently mentioned by the student teachers comprised one or more of the following areas:

(i) explaining concepts clearly;
(ii) making good and effective use of teaching aids;
(iii) providing a good learning environment in which students of diverse characteristics are encouraged to participate, voice their opinions, ask questions, and take responsibility for their own learning;
(iv) developing students' scientific thinking and problem solving skills; encouraging students to reason critically and think creatively;
(v) relating science content to daily life and highlighting how scientific knowledge is applied in the technological world;
(vi) involving students in more hands-on practical work and projects;
(vii) making science fun and taking account of students' interests in planning lessons;
(viii) nurturing a positive attitude towards science and developing interest in science.

The total number of good features mentioned in Task 2 (after watching the videos) increased sharply (almost double the number for Task 1) in areas (i) to (iv), indicating that the videos were effective in drawing greater attention to particular pedagogical strategies. There was only a slight increase in area (v), and practically no increment in areas (vi) and (vii). The latter categories were already well represented in the pre-video conceptions, so it might be expected that the videos would not play a substantial role here. In a similar vein, there was a significant drop (by about 50%) in the total number of features mentioned in area (viii) in Task 2. A possible reason is that when student teachers focused on identifying good features and areas for improvement in the two lessons, they concentrated on the prominent features and specific details of the particular lessons rather than thinking about the more general goals of science teaching. This shift of emphasis from a broad picture of science teaching (Task 1) to the classroom level (Task 2) was further supported by the sharp rise in the number of good features falling into the areas of classroom management and time management. They were scarcely mentioned in Task 1 but almost all student teachers identified either or both of these two areas in Task 2. Other features emerging in Task 2 included good question and answer skills, knowing how to motivate students, enhancing their self-esteem and infusing sound moral values to students – again, features that were well exemplified by the teachers in the videos.

In Task 2, over 50% of the student teachers indicated that the videos had a 'very strong' or 'strong' influence on their conceptions of good science teaching. These student teachers usually generated a longer and more elaborated list of additional features than other student teachers. Based on the interview data, it is found that the videos served as an effective tool not only in eliciting student teachers' existing conception of good science teaching, but also in developing and shaping their conceptions in one or more of the following ways:

(i) Recognizing exemplary practitioners in the videos as role models who can inspire them to formulate personal goals directed towards these practices;
(ii) Broadening their awareness of alternative teaching approaches not experienced in their own schooling;
(iii) Broadening their awareness of different classroom situations;
(iv) Providing proof of existence of good practices;
(v) Prompting them to reflect on their existing conceptions of good science teaching.

Significance and implications of findings

One commonly emphasized advantage of the use of classroom videos in teacher education is to provide models of teaching by showing good implementations of these models unfolding in actual classrooms (Atkin, 1998; Hattfield and Bitter, 1997). In his study investigating whether two years in a teacher education programme makes a difference to student teachers' capacity to recognize a "good" primary science teacher, Skamp (1995) noted that because exemplary teachers are often not available, videotapes could be an option to assist student teachers to focus on criteria for good teaching. Our interview data provides evidence that even prior to formal teacher training the opportunity of reviewing exemplary practices can furnish student teachers with suitable role models. Some stated explicitly that they were inspired by the teachers in the videos and would like to 'follow suit'. A few had even begun to identify specific aspects of the classroom practice of the two teachers in the videos on which they might focus their attention during the education course.

As they revealed in the interviews, many student teachers in this study had experienced a fairly traditional, transmissive mode of teaching during their own schooling. The exemplary teaching demonstrated in the videos opened their eyes to a vast range of teaching strategies that they had not previously encountered. Not only did the performances of the teachers in the videos broaden student teachers' awareness of alternative teaching approaches, they stimulated the student teachers to begin reconstructing their pedagogical knowledge. The videos, through a demonstration of good practices, have also encouraged student teachers to try out those practices in their future teaching. Some student teachers had thought that these teaching methods were impractical. Their viewpoint changed when they saw successful implementation of the methods in real classroom settings via the videos. This impact is similar to that of confronting students learning scientific concepts with observations that conflict with their preconceptions, thereby putting them in cognitive disequilibrium. Novel practices and those that seem unworkable initially are more likely to be attempted when student teachers can see clear evidence that they are both 'plausible' and 'fruitful'. Proof of existence of good practices is especially important for student teachers because it means they cannot hide behind the smokescreen of perceived implausibility.

In sum, the provision of exemplary classroom videos prior to our formal teacher training course has served as an advance preparation which 'set the stage' and made our student teachers more receptive to new teaching ideas. This is particularly important as teacher education is often criticized as too theoretical, high sounding and impractical. Introduction of innovative teaching approaches is often met with resistance and doubts from the student teachers because of the preconception they acquired through very different experiences as students.

Another important goal of teacher education is to help student teachers to act like professional teachers. To act like a teacher, they have to first perceive themselves to be a teacher. The videos seemed to have also acted as a catalyst to socialize the student teachers into the role of being a teacher. The interview data shows that the pre-entry video reviewing prior to formal instruction has got our student teachers ready to 'think like a teacher' and to begin to be cognizant of the complex ways in which the actions of teachers impact on their students. That is, such an innovation has helped to speed up the process of enculturation of our student teachers into the teaching profession.

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