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A summary of a chapter “transforming science knowledge”

from the book “learning science teaching”

Introduction

In this chapter “transforming science knowledge”, Keith Bishop and Paul Denley discuss the processes how highly accomplished science teachers use their professional knowledge to engage their students and how they utilize the engagement to result learning which they called transformation.

The book further describes and interprets the practice of the highly accomplished science teachers. Commentaries are also included on the practice of the highly accomplished science teachers supported by literature sources. The ideas which are found in this chapter are summarized below.

In their “**Transforming science knowledge”,** Keith Bishop and Paul Denley explain about how highly accomplished science teachers engage their students in learning science and about how they utilize that engagement to result in learning. And they called this process ‘transformation.

According to the writers it is not only highly accomplished teachers knowledge but what they do with their knowledge that makes the difference. So, the writers believe that by getting at the professional knowledge of the highly accomplished science teacher, and finding out more about what they do with it(by allowing them to articulate what they know), others may be able to learn from their example.

Making professional knowledge explicit

In this topic the writers tried to explore what is going on in the minds (thoughts and actions) of highly accomplished science teachers by talking about their decision making during the teaching learning process. By doing this, in order other teachers will be able to enhance their professional bases.

Pre-, inter- and post active decision making

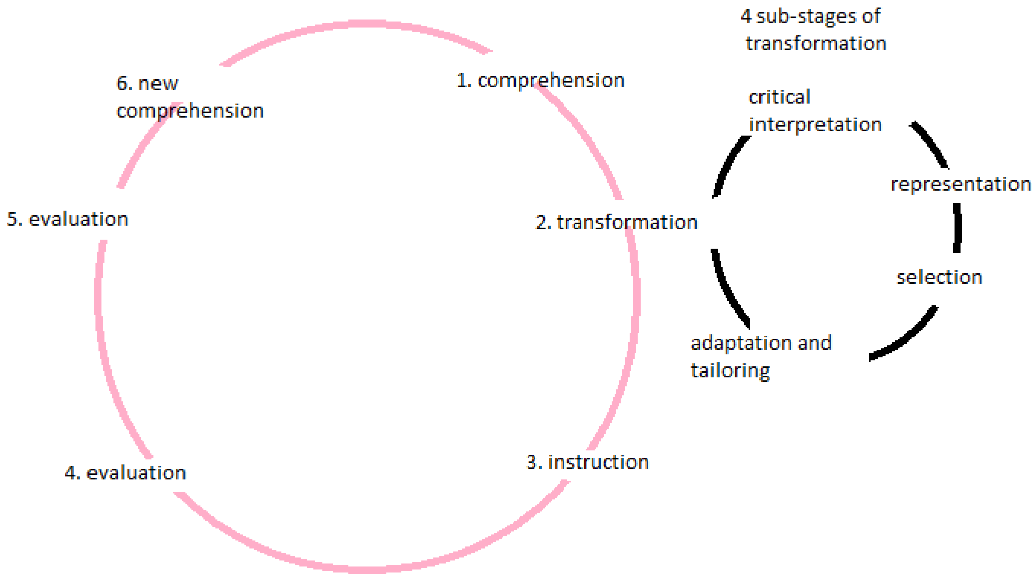
To find out aboutPre-, inter- and post active decision making, of the highly accomplished science teachers, the writers collected valuable information by asking different questions. These decisions relate to any of the following:

- organizing equipment and apparatus;
- monitoring students actions/ reading students behavior;
- monitoring students understanding;
- changing sequences;
- monitoring activity time;
- managing transition;
- monitoring and assessing learning;
- modifying plenary
- Reflection.

Generally, the highly accomplished teachers during these three stages ask questions themselves to enable them to have the decision while they are teaching.

Transformation

The writers argue that, the knowledge base of teaching lies at the intersection of pedagogy and content. And the term 'transformation' is as part of the larger process of pedagogical reasoning, at this point teachers draw on their professional knowledge to make decisions about what to teach and how to teach it.



Shulman's model of pedagogical reasoning

Comprehension

Comprehension means understanding content in a multiple waysso that the teacher has alternative explanations, able to show the students how the content relates to other concept areas, and how science is relevant to life of the students outside the classroom.

The other important point mentioned in this pedagogical reasoning is that self-awareness with regard to knowing precisely the limitations and boundaries of their (teachers) subject knowledge. This attribute was evident in all the highly accomplished science teachers.

The sub-stages of transformation

In this topic the four sub-stages are described in detail based on the highly accomplished science teachers' words and actions (i.e. after these teachers are observedand interviewed).

Critical interpretation

This is the stage that occurs during designing of lesson activities. So, highly accomplished science teachers engage themselves critically with the material and making decisions about how to teach it. And highly accomplished science teachers conceived and planned their lessons based on a very deep knowledge of the students, the extent to which they had developed good relationships with them and the physical environment in which they were working.

Representation

Most of the evidence for teachers possessing pedagogy content knowledge(**PCK)** seems to be found in this process of representation. **PCK** include, for most regularly taught topics in one's subject area, the most useful forms of those representations of those ideas, the most powerful analogies, illustrations, example, explanations and demonstrations-in a word, the ways of representing and formulating the subject that makes it comprehensible to others… **PCK** also includes an understanding of what makes the learning of specific topics easy or difficult.

So, highly accomplished science teachers understand the capabilities of students and the limits of representations so that they could be confident with in dealing with the students' questions and enquiries.

Selection

This is the choice of activity, model, analogy, and so on which is determined by all sorts of reason. Highly accomplished science teachers' selection stems from knowledge of the pupils, their cognitive abilities, their attitudes, their predispositions towards the subject matter and their predictive behavioral responses.

Adaptation and tailoring

This fourth sub-stage of transformation represents the part of the process where the teacher adds her or his distinctive twist, tweak or modification to the sequence of concepts, or to an activity or some other facet of the content of the lesson.

According to the writers all the highly accomplished science teachers are risk takers, keen to try out new ideas, strategies or approach on the basis that they are much more likely to learn about teaching science. So, for all accomplished science teachers, learning to teach science is a journey. The journey takes many twists and turns, but always at the center is the notion of pedagogical thought utilizing the concepts of reflection and analysis.

Learning to transform the content

The above four stages are integrated, are not discrete, they influence and affect one another. The adaptation and tailoring of ideas and materials involves processes of selection and critical appraisal. From the teachers' explanation about the thinking behind the activities and approaches they had designed to achieve specific teaching goals, the writers tried to show below what transformation looks like.

Transformation in practice: teaching about the heart

Jodie is a biology teacher, she teaches the topic 'heart' for grade 10 students. To teach this topic she gave the students homework to draw the diagram of the heart and the features of the heart in their books, and to learn the heart and the labels. By doing this, she believed that the pupils' would be familiar with the heart and the features of the heart for the next lesson which was the heart dissection.

On reflection, Jodie was disappointed with the outcome of the heart dissection despite the students being engaged in the activity. Although the students enjoyed the activity, it was not as good a learning experience as she wanted it to be. Assessment of learning indicated that pupils had learnt some of the vocabulary of the heart, but not how it related to the actual position in the heart.

By **critically engaging** herself with the content she identified 'form and function' as the big idea. She changed the order of study because believing that understanding of form and functions of the heart was essential before the pupils' undertook the dissection. Further, she decided that they themselves would model the functions of the heart and the reasoning was that she could create opportunities to explore their thinking as the modeling process took place.

In recognition of the varying cognitive abilities of the students, Jodie **adapted and tailored** the model to suit their learning and attitudinal needs. Pupils' were also able to evaluate this model for accuracy, for example pointing out that one of the drawbacks of the model was that valves were not present.

Having developed her subject knowledge through research and reappraised completely her thinking about how the students learn, she has **transformed** the subject matter into a set of activities which she believes is now fit for purpose.

Activity

- At the start of the topic, a group of pupils take part in a role play that has a pupil being 'dissected' by a 'doctor'.
- Heart dissection comes towards the end of the heart and circulation topic.
- Comparison of heart diagram from text book with actual heart that has been dissected; differences identified and diagram evaluated.
- Heart dissection is carried out by me as a demo using the digital visualizer with images projected onto the whiteboard, simultaneously with the pupils dissecting their heart.

- Modeling used to show the heart pumping cycle.
- Pupils encouraged to make gestures that match the vocabulary of the heart, for example a V with their two hands when the word ‘ventricle’ is used.

Generally, at all stages she has the opportunity to encourage the students to relate form and function. The whole approach is personalized, interactive, and allows Jodie the opportunity to improvise and respond as necessary to the students learning needs.

Section 2: reactivity series

The context

In this instance, the class comprises a small group of around 12 year 10 (14-15 age group) students, who mostly have learning and behavioral **difficulties of some kind.**

The lesson

This lesson focuses on the concept of chemical reduction within the context of metals and the industrial processes associated with metal extraction. Although Ursula introduces the concept of ‘reduction’, for this group her principal aim is to consolidate the development of a relatively limited conceptual framework for their GSCE science, where the main idea is that important industrial and domestic materials are extracted from the earth.

‘What Ursula was interested is that the concepts to be embedded in the students mind for a longer period of time. So, she wanted to focus on building and linking the concepts.’

Therefore to do this students are reminded at every opportunity about what they have done before and how what they are doing now to prepare them for what comes next. It was carried out in the form of question and answer.

Commentary

Integrative theme

In this lesson, the theme is the reactivity series which Ursula uses as a point of reference each time she gets the students to think about how easily a metal can be extracted from its ore. This way of conceiving the learning through a series of lessons, rather than a more atomistic approach, enables the teacher to link ideas, concepts and episodes to show students how they are related. Moreover, by having a clear longer- term conceptual frame-work comprising one or more integrative themes helps to ensure students get a sense of their progress and achievement.

Activity 1

-assigning metals to objects in photographs.

Once the group is well underway with the activity, Ursula gives them a time limit and expected outcomes for the activity in order to make the transition to the next phase.

Conceptual development

Ursula establishes the conceptual back ground they need to make sense of the practical activity.' She knows they know the words element, compound and mixtures as labels, but not as a means of interpretation'. This practical activity, therefore, has the potential to provide concrete examples of all three concepts.

Commentary

Language in science

What Ursula recognizes is that evidence of student understanding comes when students are able to use the words in different contexts or when they use them to contribute to explanations of other concepts or phenomena.

Activity 2

- Demonstration

Ursula reminded the students of the events of the previous week in order to make clear connection with the practical activity. She guided the students to where she wanted them to be by question and answer. Ursula projected further examples of reactions that illustrate the chemical principle of 'reduction' and which reinforce the idea that it is possible to predict how difficult the reaction might be if you know where the elements lie within the reactivity series relative to carbon.

Activity 3

Practical work

-extracting iron from iron oxide

This is an illustrative activity designed to achieve the principal learning outcome. There is no investigative aspect. Its purpose is simply to provide students with a concrete model of metal extraction that shows that iron comes from a completely different material, an orange/red powder that they commonly called 'rust'. According to Ursula the incorporation of practical work is vital if students are going to remember their science.

Commentary

Learning by doing

Both students and teachers valued participation in practical work. Students tended to associate doing things with learning. The highly accomplished science teacher, however, was far more skeptical. 'Learning by doing' is a phrase known to every teacher, but in science there is only limited evidence to suggest that doing results in learning**. In fact, sometimes it can lead to confusion if its purpose is not absolutely clear to the student.**

Consolidation

By bringing the students to the front ones more Ursula signifies that she want to share their observations and give them an opportunity to test the magnetic properties of the materials.

Activity 4

-testing the magnetic property of the material

If the extraction process works, then the presence of native iron should be detectable with a magnet. The students are asked to predict what they would expect to see and are given a short worksheet to complete that summarizes the main learning points.

The students test the products of their practical activity for iron and Ursula takes a final opportunity to get around all the groups to commend them on their efforts and check once more what they have learnt from the lesson in order to decide how to proceed in the next lesson. For Ursula this was assessment for learning in practice.

Ursula's beliefs and theories (personal philosophies) about science teaching

- Recognizing students as individuals who need to be motivated and encouraged to learn how to learn.
- Ursula sees science as a practical subject which students learn best when they are doing it(she combine this with her desire teaching for understanding).

Ursula's professional knowledge

Knowledge of content	Broad knowledge of content; identifies theme to give subject matter a strong sense of coherence
Knowledge of learners and learning	Planning built round detailed knowledge of students and deep insight into their learning potential
Knowledge of context	Use of broad knowledge and experience of how to develop community partnerships to lead school as specialist science college
Knowledge of curriculum	Broad knowledge of related topic
General pedagogical knowledge	Knowledge of management techniques that will organize and motivate the students.
Knowledge of values ends, purposes	Knowledge of links between the school science curriculum and science for citizenship