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COMMUNICATIVE SUBJECT TEACHING FOR MAKING CHEMISTRY TEACHING RELEVANT

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Розглянуто принципи комунікативного навчання в Національному авіаційному університеті України в проекті викладання хімічних, екологічних та інших інженерних дисциплін англійською мовою. Застосування комунікативного навчання при використанні сучасної комп'ютерної мультимедії і досягнень педагогіки з даного напряму дозволило істотно підвищити мотивацію студентів при вивченні низки інженерних дисциплін шляхом пояснення звязку дисциплін із практикою.

Ключові слова: комунікативне навчання, мотивація

There are many ways to teach subjects. One of the most recent is called Communicative Subject Teaching (CST). This method is learner-centred and emphasises communication similar to real-life situations. We use CST principles in the National Aviation University of Ukraine in the project of teaching chemical and ecology related engineering disciplines in English language.

The role of the instructor in CST is different from traditional teaching methods. In the traditional classroom, the teacher is “on duty” and "controls" the learning. In CST the teacher serves as a facilitator, allowing students to be in charge of their own learning. The teacher still gives direction to the class and sets up exercises and control works, but the students do much more speaking than in a traditional classroom. This responsibility to participate as a rule leads to an increased sense of confidence in using the subject in practice.

Multimedia is an ideal way to teach any subjects including engineering ones using CST as a theory. It allows for realistic simulations of teacher-student communicative situations. Many such programs are interactive tutorials, such as interactive animations in studying chemistry "The structure of atom" or "Gas laws". They place the learner in a situation in which understanding basic communication, its social and cultural contexts are vital to advancing in the animation tutorial “game”.

CST is usually characterised as a broad approach to teaching, rather than as a teaching method with a clearly defined set of classroom practices. As such, it is most often defined as a list of general principles or features. One of the most recognised of these lists is David Nunan’s (1991) five features of CST:

- An emphasis on learning to communicate through interaction in the target subject.
- The introduction of close to authentic virtual laboratory animations into the learning situation.
- The provision of opportunities for learners to focus, not only on subject but also on the learning process itself.
- An enhancement of the learner’s own personal experiences as important contributing elements to classroom learning.
- An attempt to link classroom subject learning with subject activities outside the classroom.

These five features are used by practitioners of CST to show that they are very interested in the needs and desires of their learners as well as the connection between the subject as it is taught in their class and as it used outside the classroom.

Unlike the traditional method of teaching, which relies on repetition and drills, the communicative approach can leave students in suspense as to the outcome of a class exercise, which will vary according to their reactions and responses.

Multimedia computer simulated exercise puts students in a real-world situation where they must report information overheard. Most likely they have an opinion of the topic, and a class discussion could follow, in the target subject, about their experiences and viewpoints.

Teachers in communicative classrooms will find themselves talking less and listening more - becoming active facilitators of their students' learning (Larsen-Freeman, 1986). The teacher sets up the exercise, but because the students' performance is the goal, the teacher must step back and observe, sometimes acting as referee or monitor. A classroom during a communicative activity is far from quiet, however. The students do most of the speaking, and frequently the scene of a classroom during a communicative exercise is active, with students leaving their seats to complete a task.

Because of the increased responsibility to participate, students may find they gain confidence in using the target subject in general. Students are more responsible managers of their own learning (Larsen-Freeman, 1986).

In the meantime, research, (Holbrook, 2005) has shown that chemistry teaching:

- is unpopular and irrelevant in the eyes of students (Kracjik, 2001; Osborne and Collins, 2001: Pak, 1997; Sjoberg, 2001).
- does not promote cognitive skills (Anderson et al, 1992; Zoller,1993)
- leads to gaps between students wishes and teachers teaching (Hofstein et al.2000; Yager and Weld, 2000; Holbrook and Rannikmae, 2002)
- is conservative, teachers are afraid of change and need guidance (Aikenhead, 1997; Bell, 1998; Rannikmae, 2001).

A factor common to all of the above seems to be the lack of relevance of chemistry teaching. Although school chemistry programs set out to develop conceptual understanding in students and an appreciation of the way scientists do things, the relevance of the teaching in providing a useful education is suspect (Pak, 1997; Yager, 996; Champagne et al, 1985; Lederman, 1992; Novick and Nussbaum, 1981; Osborne and Freyberg, 1986; Ryan and Aikenhead, 1992). The stress on conceptual understanding and the appreciation of the nature of science tends not to be relevant for functionality in our lives, i.e. relevant to the home, the environment, future employment and most definitely for future changes and developments within the society. Rather, the understanding tends to be geared to internal concepts within the subject itself. Concepts such as atomic structure, or chemical bonding are almost universally section headings in chemistry courses, yet in daily life, for example -improving the quality of the air for our health, is potentially a much more relevant starting point.

Generalising (Holbrook, 2005), chemistry curricula tend to put the subject first, and applications just a second. Forgotten is that relevancy is in the processes and products we utilise in society, and only afterwards in the understanding (should we wish to utilise scientific principles in solving a problem or making a decision). It would seem we need to find ways to initiate teaching based on societal situations and then develop the conceptual learning that allows students to appreciate the relevance of the science (Holbrook, 1994).

According Holbrook relating chemistry to the developments in society is not new. Many so-called STS programs do this (Yager 1996, Lutz 1996). But while STS or context-based teaching programmes have included social values in the teaching, the relevance of the course is still suspect. It seems that to achieve relevance there is a need to go beyond the simple inclusion of societal links. Attitudes towards the learning of chemistry are important and or this the need for interacting with issues in society by utilising the conceptual chemistry acquired is important but insufficient and there is a need to go further and incorporate the making of rational decisions geared to societal concerns. However, these are areas that are rarely considered in many chemistry courses (Rannikmae, 2001). To better understand the issue of relevance of chemistry teaching, it is suggested three aspects need to be considered (Holbrook, 2005):

- What are we trying to do?
- How to guide teachers?
- What could be relevant teaching materials?

Or to express this in an alternative manner, the relevance of chemistry needs to embrace:

a) a relevant chemistry education philosophy;

b) a relevant curriculum;

c) relevant teaching approaches to the teaching of chemistry in schools;

d) relevant assessment and evaluation strategies;

e) relevant professional development for teachers.

As a first step to better appreciating the type of chemistry teaching needed, it is appropriate to establish the meaning of chemistry. Simply put, this has been suggested as a body of knowledge and a way of thinking.

Building on such a concept, the nature of chemistry needs to accept that chemistry knowledge is simultaneously reliable and tentative. And also the processes of chemistry utilise the so-called scientific method, which while not being one single entity, captures the chemists demand for naturalistic explanations supported by empirical evidence and involving observation, rational argument, inference, scepticism, creativity and the importance of being able to replicate work.

Education is an activity to acquire the knowledge, skill and values, both personal and social, deemed appropriate for the society. In the past, education was sub-divided into cognitive, affective and psychomotor domains. Today, education components are more likely to cover intellectual, communicative, social and moral, personal and physical, and aesthetic attitudes (Hong Kong Curriculum Development Institute, 1993). However, by noting that communicative and aesthetic qualities are linked to the individual, whereas social and moral are more societal aspects, it is suggested that the sub-division can be more conveniently expressed as Cognitive, Personal and Social domains. While the cognitive domain is still stressed, there is a clear recognition of the need to educate the individual and to develop social attributes towards creating responsible citizens.

Holbrook, 2005 puts forward a question: is chemistry education 'chemistry through education', or 'education through chemistry'? In other words, does it need to be considered as a component of chemistry as a body of knowledge, or as a component of education ?

This author gives the following table (Table 1.) for a comparison illustrating the differences in emphases between 'chemistry through education' and 'education through chemistry'.

Table 1. Chemistry through education versus education through chemistry

Chemistry through Education	**Education through Chemistry**
• Learn fundamental chemistry knowledge, concepts, theories and laws.	• Learn the chemistry knowledge and cconcepts important for uunderstanding and appreciating socio-scientific issues within society.
• Undertake the processes of chemistry through inquiry learning.	• Undertake investigatory scientific pproblem solving to better understand the chemistry background related to socio scientific issues within society.
• Gain an appreciation of the nature of science. Undertake practical work and appreciate the work of scientists.	• Gain an appreciation of the nature of Science. Develop personal skills related to creativity, initiative, safe working, etc.
• Develop positive attitudes towards chemistry and scientists.	• Develop positive attitudes towards chemistry as a major component in the develop of society and scientific endeavours.
• Acquire communicative skills related to oral, written and symbolic /tabular/graphical formats.	• Acquire communicative skills related to oral, written and symbolic /tabular/ graphical formats.
• Undertake decision making in tackling scientific issues.	• Undertake socio-scientific decision making related to issues arising from the society.
• Apply the uses of chemistry to society and appreciate ethical issues faced by scientists.	• Develop social values related to becoming a responsible citizen and undertaking chemistry- related careers.

Holbrook has pointed out that nothing so far has been said which is contrary to the school curriculum. Nor is it contrary to the school chemistry curriculum. But nevertheless, it seems to be a major change and seems to be rarely practised. He proposes a shift of emphasis in the teaching of chemistry. The shift is from learning chemistry as a body of knowledge to promoting the educational skills to be acquired through the subject of chemistry. And as attempts to gain 'education through chemistry' simply by gaining knowledge are shown to be unsuccessful, the approach needs to shift from one bound by subject chapter headings, or sections to one which more closely relates to the issues and concern within society.

The shift from conceptual learning within a subject context to conceptual learning in a social context, and which leads to socio-scientific decision making, can be illustrated by converting a concept map into a form more closely linked to the teaching and into a form which incorporates the socio-scientific decision making. This shift is promoted as a major attempt to move to more relevant chemistry teaching in the eyes of students.

The shift basic suggestion is that the teaching of a sequence of chemistry lessons begins from a relevant socio-scientific context. The teaching progresses from the societal (the familiar), to the chemistry concepts (the unknown), which are needed to better appreciate the issues, or concerns, and then proceeds to the socio-scientific decision making needed (the purposeful learning involving all educational domains). Teachers need to recognise that curricula promoting chemistry fundamentals, grouping chemistry concepts for scientific convenience, rather than for popularity, is not the approach to promote education through chemistry. Such an approach leads to an academically perceived course that is likely to be abstract, difficult ad irrelevant.

Jack Holbrook in 2005 have suggested a way forward for chemistry teaching. He mentions that much has been written about student centred teaching and teacher ownership of the teaching approach if the teaching is to be meaningful for students (Mamlok, 1998; Rannikmae, 2001b). With this in mind, it is suggested important that teachers are able to develop teaching materials which reflect the relevant teaching approaches being advocated.

As the teaching material is expected to relate to a societal situation, which students find relevant, it is suggested that the title of the teaching-learning material is likely to be a question. In this way, the title is related to an issue of concern for which a decision is required and for which the student first needs to gain chemistry conceptual ideas. The title tries to avoid the use of chemistry conceptual expressions, because these may be unfamiliar to the students, or not seen as relevant.

The title is followed by an introduction. Each teaching material needs an introduction. This is a very short outline of what the teaching material is about and guides the reader towards expectations they can have for utilising this material in their teaching. Learning outcomes are specified at the beginning of the materials so as to clearly specify the learning in terms of:

a. the intentions for learning based on the three educational domains, and

b. whether the learning has been achieved.

The emphasis is thus on the outcomes of learning, rather than the process by which they are achieved, although student participation in the process is considered crucial for motivation and hence interest.

Where the science conceptual outcomes are clearly specified in the exemplar materials, it is essential that they relate to the issue or concern that drew attention to the relevance of this learning. Active learning is promoted by learning outcomes related to chemistry process skills, whereas stress on the conceptual learning will mean additional outcomes in the science conceptual area.

The social values learning outcomes form the focus of the learning for all, except for younger students (primary level), and are usually expressed in a socio-scientific decision making format. Such decisions need justification and will draw on the science conceptual learning, as well as other societal factors, such as environmental issues, economic issues, social factors, political factors to explain the decisions made.

The main component for the students is the student script. Within this a scenario sets the scene for activities to then be undertaken by the students. The scenario is related to the society, points to an issue or concern on which the script draws and thus builds on the title of the material. Usually the more personal the scenario, the more the student can identify with the situation and hence find it more relevant.

Two important skills are addressed in teaching for relevance – scientific problem-solving and socio-scientific decision-making. The first is practised by involving students in investigatory activities in which the ultimate goal (acquired by practice over a number of occasions) is to be able to identify the scientific question, plan the investigation, predict the likely outcomes, identify and control variables, undertake the observations or recording of measurements made, decide on the number of a variety of observations/measurements, determine how to record the data, interpretation of the findings, presentation of the finding in a suitable format and conclusions of the investigation.

The second important skill is being able to make a justifiable decision (which is the ultimate purpose of the teaching material), but based, of course, on the scientific conceptual learning gained through the teaching material plus other social factors that may impact on the decision. The decision is not static i.e. the actual decision make could

change with time, location and the attitude of the persons making the decision. A further goal therefore is to try to arrive at a consensus decision to show that it is a societal, rather than an individual decision that is important.

From the teacher's point of view, a teacher's guide is considered as the main part of the script. This gives guidance on how to use the script, in the manner intended. It assists the teacher by putting forward a teaching strategy, detailing how the intended educational learning outcomes are to be achieved, suggests assessment approaches and includes any additional handouts for the students that the teacher may wish to give later in the lesson.

A section on 'achieving the learning outcomes' is very important. It links the student activities to the learning outcomes intended. A section on 'assessment' is very much related to the achievement of the learning outcomes. It outlines the manner in which feedback from the students can be obtained (in a formative and/or summary manner) and hence help the teacher determine whether the activities have enabled the students to actually achieve the learning outcomes put forward. Clearly, a marking scheme for formative assessment must be simple, if it is to operate in the classroom, in the manner described. It needs to be possible for teachers to award the mark through a variety of feedback mechanisms, depending on the situation.

Among the methods suggested are:

- observation of the students (by watching student activities, by watching students reacting to teacher comments, by listening to their comments in group work),
- interacting with students orally (teacher asks questions of different types – informational, procedural, reasoning, predictive, etc, student initiated by asking questions, by viewing/reading student's work),
- making use of student-student assessment (students cross mark test/quizzes)
- Teacher listens to the discussions and determines whether student's socio-scientific decisions are meaningful and then awards a "mark" according the following trends:
- a student has not made a meaningful contribution to the decision-making discussions.
- Participates in the discussion and recognises that a choice can be made on scientific as well as economic grounds. Considers other factors e.g. environmental or social, only when given guidance by the teacher.
- Plays a significant role in the discussions and reflect on many viewpoints from which a discussion could be made. Selects an appropriate choice based on social as well as environmental, economic and scientific grounds. Appreciates disparity that may occur between the best choice and actual practice within society.

With the science related to the world of relevance of the student, the science is unlikely to be fully covered in the standard textbook. An additional component of the material is thus vital information for the teacher.

Some support for the teacher is given also through suggested student handouts. They are designed to be copied, or photocopied and given to the students when the teacher feels this is appropriate.

At the teacher workshops of ICASE Holbrook and Rannikmae in 1997 have initiated a development of some promising teaching materials with a goal to give a teacher an ownership of the need for greater relevance through developing skills in creating suitable teaching material.

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