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MICRO AND MACRO LEVEL PHENOMENA IN CHEMISTRY: LEARNING DIFFICULTIES, DEFICIENCIES AND REMEDIAL MEASURES

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Abstract:

It is a well experienced and well transmitted belief that chemistry is a difficult subject. This subject is not well accepted to all the learning communities concerned. Chemistry as a discipline comprises of so many facts, symbols, structures and reactivity of matter and energy. In this sense understanding of chemical phenomena is not an easy task. On the other hand misconceptions on the part of the chemistry teachers and improper delivery of the content materials to the learners has made the subject tougher one. In this investigation we are to explore the probable causes of learning difficulties and deficiencies in chemistry. Some plausible remedial measures have been addressed to provide meaningful learning of chemical phenomena on the part of the chemistry knowledge seekers.

Key Words: Abstract Concept, Symbolic Chemistry Learning, Difficulties, Deficiencies & Remedial Measures

Introduction:

After admitting to any course, students begin their study with a set of viewpoints about the nature of teaching and learning and what they intend to achieve through it. These viewpoints are consequent of interaction with family, community, society and earlier school environment as well as their current ambition, goal and motives. The effective teaching strategies for meaningful learning can be devised by the complete understanding of students learning processes (Biggs & Moore, 1993). Chemistry is one of the most important branches of science and is a difficult subject to teach and to learn at both secondary and tertiary levels. It enables learners to understand what happened around them and provides students the opportunity to make connections between chemistry, other disciplines and aspects of everyday life. Chemistry as a discipline comprises of so many facts, symbols, structures and reactivity of matter and energy. Learning about Chemistry requires the coordination of a complex set of cognitive, affective, and motivational strategies and skills. Major learning difficulties are due to the particular views of micro and macro level phenomena in Chemistry learning that in many ways contradict intuitive and everyday views of the learners. Numerous reports support the view that the interplay between macroscopic and microscopic worlds is a source of difficulty for many chemistry learners. Examples include the mole concept (Gilbert & Watts, 1983), atomic structure (Zoller, 1990; Harrison &Treagust, 1996), kinetic theory (Abraham *et al*., 1992; Stavy, 1995; Taylor &Coll, 1997), thermodynamics (Abraham *et al*., 1992; Özmen & Ayas, 2003), electrochemistry (Garnett & Treagust, 1992; Sanger & Greenbowe, 1997), chemical change and reactivity (Zoller, 1990; Abraham *et al*., 1992), balancing redox equations and stereochemistry (Zoller, 1990), chemical bonding (Peterson & Treagust, 1989; Taber, 2002; Taber &Coll, 2003; Coll & Treagust, 2003; Özmen, 2004; Ünal*et al*., 2006), etc. As a result, major misunderstandings occur when students try to comprehend chemical explanations within the framework of their pre-instructional conceptions. That is why learning Chemistry can be a painstaking process of a sequence of gradual changes of students' pre-instructional conceptions towards new chemistry conceptions.

Learning Difficulties:

Teachers and educationists make frequent use of the term 'learning difficulties', but no generally accepted definition exists of their precise meaning. It is possible, of course, to apply the term 'learning difficulty' to any situation where a student fails to understand a relatively easy concept or notion that we wish him or her to acquire as the result of some instructional intervention. Such description of 'learning difficulty' is of little practica1 value, though; it is too general and all-embracing and, in addition, does not even hint at the possible causes of such difficulties (Kempa, R. F., 1991).

Understanding and learning core science concepts and principles, including those in chemistry, are difficult; many research studies have revealed major learning difficulties and identified key causes of these difficulties. A learning difficulty may be said to exist in any situation where a student fails to grasp a concept or idea as the result of one or more of the following factors:

- ✓ The nature of the pre-instructional conceptions already possessed by the student, or the inadequacy of such knowledge in relation to the concept to be acquired.

- ✓ The demand and complexity of a learning task in terms of information processing, compared with the student's information-handling capacity i.e. working memory space overload.
- ✓ Language of learning and teaching (LOLT) i.e. Communication problems arising from language use, e.g., in relation to technical terms or to general terms with context-specific specialized meanings, or the complexity of sentence structure and syntax used by the teacher (compared with the student's own language capacity).
- ✓ A mismatch between instructional approaches used by the teacher and the student's preferred learning mode (learning style) arises from misconceptions on the part of the chemistry teacher lacking the concept of Pedagogical Content Knowledge (PCK) results improper delivery of the content materials for meaningful learning.
- ✓ Motivation to learn is an important factor controlling the success of learning.

Remedial Measures of Learning Difficulties:

When planning instruction in chemistry, for more effective learning, teachers need to take into consideration a much broader range of issues than the chemistry concepts themselves. These issues are to be aware of and take into consideration (*a*) students' prior knowledge, (*b*) the multiple ways in which chemistry phenomena can be represented, (*c*) the meanings of the same and similar terms used in chemistry and in everyday life, and (*d*) the chemistry of everyday life.

When students become deeply engaged in their own learning, they frequently have a better understanding of chemistry and of the role of chemistry in their daily lives. Furthermore, the lessons are more pleasing experiences both for teacher and students (David Treagust, Reinders Duit and Martina Nieswandt, 2000).

The teacher's working memory is already organized, but this is not the case for the learner. Each learner has to analyze the information coming in and organize it for himself, or be helped to organize it, if the learning is to become part of him. If he tries to take on the teacher's information and structure, he has to resort to rote memorization which certainly does not guarantee understanding (Johnstone 1984). This problem of complex information processing and working memory space overload can be solved by using modern pedagogical practices like chunking, mnemonics, mind-mapping etc.

As students progress in their science studies, they encounter more special words to describe and explain scientific phenomena that differ in meaning between the everyday and scientific meanings, creating additional learning problems. Ina scientific context, a word is frequently harder to understand because it has a more precise meaning and this extra precision requires more thoughtful effort in the side of teacher during communicating in the class (Cassels & Johnstone, 1984).

Research studies have indicated that students have responded favourably to the use of everyday references (Ramsden, 1994) which reduces the misconceptions too. In a typically content-driven curriculum, examples are provided to support the content, but the Learner centered curriculum should be driven by everyday examples which are a fundamental change in the approach to presenting and explaining scientific phenomenon (Campbell et al., 1994). Teacher should be well aware of this concept of Pedagogical Content Knowledge (PCK) before preparing to deliver a lesson.

There are four motivational traits that are attributable to students' needs (Trumper, 1995). Learners differ with respect to their preference for and responsiveness to different instructional features. According to this the four major motivational patterns are identified: the achievers, the curious, the conscientious, and the sociable. Researches reveal that students of different motivational patterns have their preferred modes of learning as well (Hofstein and Kempa 1985). Teachers had to identify the proper motivational patterns of learners and apply suitable teaching strategies according to the learning mode to motivate them.

Learning Deficiencies:

On the other hand deficiencies in understanding may arise from learning disabilities. Learning Disabilities refer to a number of conditions that might affect the acquisition, organization, retention, understanding or use of verbal or nonverbal information. Learning disabilities result from impairments in one or more processes related to perceiving, thinking, remembering or learning(Mather, N. & Goldstein, S. 2001). The learning deficiency is another key factor to cause the learning difficulty. The learning disabilities can interfere with learning basic skills such as reading, writing and/or mathematics. They can also interfere with higher level skills such as organization, time planning, abstract reasoning, long or short term memory and attention. These interferences also deplete quality of the learning of chemistry. They include:

- ✓ Arithmetic Disorder (Dyscalculia) is generally characterized by difficulty in learning or comprehending mathematics. It affects a person's ability to understand and manipulate numbers or understand numbers themselves (Butler, F., Miller, S., Crehan, K., Babbitt, B. & Pierce, 2003).
- ✓ Writing Disorder (Dysgraphia) is generally characterized by distorted writing in spite of thorough instruction.
- ✓ Reading Disorder (Dyslexia) is generally characterized by difficulties with the alphabet, word recognition, decoding, spelling, and comprehension.

- ✓ Spelling disorders (Dysorthographia) are generally characterized by difficulties with spelling.
- ✓ Auditory processing disorder describes a variety of disorders that affect the way the brain processes or interprets what it hears even though the student might have adequate hearing.
- ✓ Visual perception disorder involves difficulty making sense of what is seen, even though vision is intact.
- ✓ Sensory Integration Disorder is associated with the ability to integrate information from the body's sensory systems and Information from the senses are not interpreted in ways that it can be used efficiently by the brain.
- ✓ An organizational learning disorder is a type of learning disability related to challenges with executive functions and frequently accompanies other learning disabilities.
- ✓ Social cue disorder has difficulty behaving in an automatic way by picking up on spoken and an unspoken cue is a complex process (Mather, N. & Goldstein, S., 2001).

Remedial measures of Learning Deficiencies:

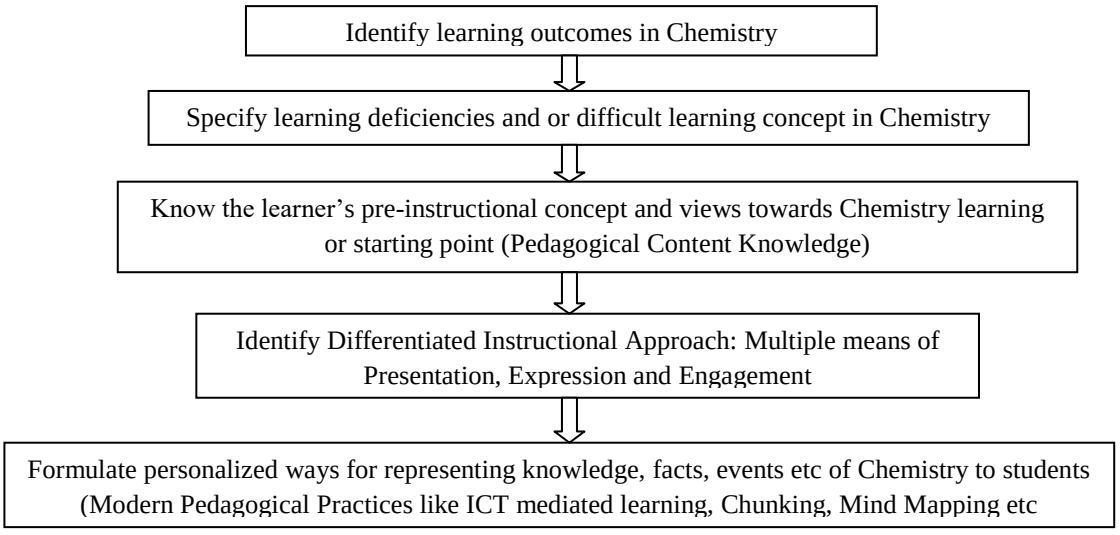
Differentiated instruction is the solution to the learning disabilities. It is a framework of flexible instructional approaches to teaching in which a teacher plans and carries out varied approaches to address content, learning processes, learning style, practical procedures, presentation strategies, and assessment tools. It recognizes and accommodates varied learning styles. It provides learning activities that expand students' opportunities for acquiring information and demonstrating learning, as well as for enhancing social participation and inclusion. It results in a more personal, proactive learning environment, inclusive of a wide variety of learners.

The driver for Differentiated instruction is the philosophy of proactively addressing needs. Differentiated instruction for learning is integrated into regular instructional planning as a mechanism to make diversity the norm. It provides support for all students and motivates through the element of choice. The key features of Differentiated instruction for learning are

- ✓ Adjustments to personalize learning for all students, not just those with disabilities.
- ✓ Flexibility is the key to providing a curriculum that does not stigmatize or penalize students for having learning differences.
- ✓ Curriculum materials are as varied and diverse as the learning style and needs of students.
- ✓ Multiple means of presentation, to provide various ways of acquiring information and knowledge (e.g. buddy activities, use of concrete manipulative, video, computer technology, audio texts).
- ✓ Multiple means of expression to provide students with alternatives for representing learning beyond written work (e.g. video, teaching a peer, information booth, presentation, drawing, sculpture and drama).
- ✓ Multiple means of engagement to tap into students' interests, offer appropriate challenges and/or increase motivation.
- ✓ Respect for students' learning styles and personal attributes, while still focusing on the required learning outcomes.

Proposed Universal Design for Learning:

A Universal design for learning may be developed which should be based on an integrated framework of instructional approaches. This instructional design will be able to recognize and accommodate varied learning styles according to situational demand of learners as a remedy against poor performance in chemistry irrespective of learning difficulties and deficiencies. A proposed framework of universal design is depicted in Figure1.



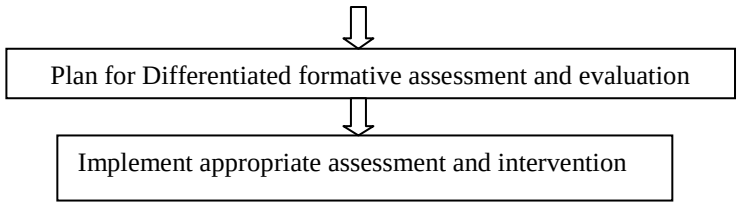


Figure 1: Proposed Framework of Universal Design

Conclusion:

The teaching and learning process depends on the particular content and in reflections on student starting points. These student starting points include pre-instructional conceptions about the phenomena and concepts to be learned, views about chemistry and chemistry teaching, mental abilities or disabilities, interests and motivations, as well as key features of daily life. Research has shown that learning for understanding needs an active, self-reflective and self-responsible learner whereby students construct their own knowledge. The teacher can only provide help in this construction process because knowledge cannot be transferred to the students' brain in a similar way as bytes are transferred in a computer's memory. Unfortunately, students engage in the painstaking construction process only if they see the need to learn and the process is only successful if students are carefully guided from their pre-instructional conceptions and views towards the chemistry concepts. Under these circumstances, a universal instructional design will be helpful for assimilating and understanding of chemical phenomena.

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