ATTRACTIVE EDUCATIONAL STRATEGIES IN TEACHING AND LEARNING CHEMISTRY

Boshra M. Awad,
Chemistry Department, Faculty of Women for Arts, Science and Education, Ain Shams University
e-mail: boshra_awad@women.asu.edu.eg

ABSTRACT

The main objectives of this article is to find attractive and appropriate educational strategies and methodologies that could be used in teaching and learning chemistry in order to attract new generations to appreciate studying the most important discipline in science; chemistry. Chemistry is considered as the central backbone for science since its concepts and theories can explain all the scientific phenomena. Since science is the core of the human sustainability, therefore improvement of chemical education would definitely result in improvement of social sustainability. Attractive educational strategies in teaching and learning chemistry can be achieved by using attractive and interactive appropriate methodologies such as Systemic Approach (SATLC), E-learning, M-learning, and any other tools in which modern technologies are integrated. *[African Journal of Chemical Education—AJCE 7(3), Special Issue, October 2017]*

INTRODUCTION

Chemistry is the central part of all science subjects due its special concepts and importance. But Chemistry is a very complicated discipline of science, starting from atomic structure, reaction kinetics, energetics of bond breaking, formation, micro-molecules, to macromolecular compounds. All of chemical processes require deep understanding of the chemical concepts and basics, training on scientific inquiry and problem-solving skills. There are some challenges facing teaching and learning chemistry, so that the word "chemicals" has become linked with environmental pollution, unsustainable growth and unhealthy toxins, many students prefer to avoid studying chemistry, even if they have an interest in science: because of its reputation for lowering grade point averages. Moreover, many teachers are not up to the job of inspiring and not enthusing to their students, due to their traditional lecturing style as it allowed for maximum content coverage and it was the mode with which they were most familiar. In recent years, the effectiveness of the traditional unbroken lecture method has come under the scrutiny of science teachers for its inability to reach students with a wide range of abilities and learning styles, and the passive atmosphere it creates in a classroom. When an instructor chooses to use an alternative pedagogy, there is often concern about whether portions of the course content are sacrificed. However, to make chemistry easy, funny to learn, important and applicable we always need to find strategies that make the above parameters are well addressed.

Among the mechanisms method of teaching and using appropriate instructional materials are the important strategies used to make chemistry attractive and effective. This is a common concern, though it is our impression that many faculties involved in curriculum reform feel that the benefits provided by alternative instruction.

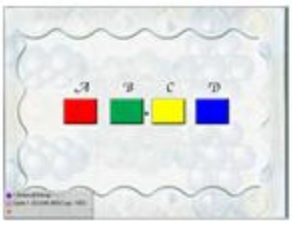
This article will focus on some attractive educational strategies and methodologies that

enhance teaching and learning chemistry through, Systemic approach, ICT; e-learning, virtual class rooms, video streaming, and self-paced education, Satellite; Videoconferencing, and m-learning, in order to outweigh the loss of attraction towards chemistry education. Following are some attractive educational strategies that empower teaching and learning chemistry.

1. Systemic Approach in Teaching and Learning Chemistry

1.1. Differentiation Between Systemic and Systematic Approach

At the beginning we should differentiate between systematic and systemic approach. Systematic, means something is well organized and arranged according to a set of plan or is grouped into systems. Whereas, systemic means that something has or can affect the entire system. Systemic approach describes something that belongs to, work together with, or can affect the entire body or system as a whole [1]. We represent Figs. 1 and 2 to simplify the difference between systemic and systematic approach in a system consisted from items A, B, C, and D. In the systemic approach (Fig. 1) the items (A-D) are well arranged in an organized order so that you cannot see A through D, whereas in the systemic approach (Fig. 2), all the items (A-D), are affecting each other and seen synchronously.



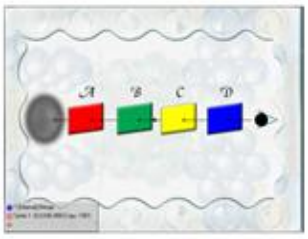


Fig.1 (Systematic Approach)

Fig.2 (Systemic Approach)

1.2.Systemic approach in Teaching and Learning Chemistry

Systemic Approach in Teaching and Learning provides inter-relationships between concepts, methodologies, or/and disciplines. It leads to more global thinking, and enhances the quality and quantity of chemistry understanding. It proves to be very effective in the assessment of the educational processes [2].

The Systemic Approach in Teaching and Learning (SATL) is based on constructivist principles and involves the creation of closed cluster concept maps called systemic diagrams. The SATL technique encourages deep learning, as opposed to rote learning. Examples in the use of SATL methods in teaching chemistry are presented. Experimental evidence collected in Egyptian schools is presented to illustrate the efficacy of SATL methods on student achievement. It is suggested that SATL methods mimic current understanding of how the human brain functions, as the basic reason that SAL methods are successful. The authors reported success in students' achievement using SATL methods in chemistry courses has been reported for the following subjects: aliphatic chemistry, aromatic chemistry, heterocyclic chemistry, analytical chemistry and physical chemistry [3-11].

2. Using Technology to Enhance the Effectiveness of Chemistry teaching and learning

Chemistry is dynamic; molecules are constantly moving, even when they are not reacting so that it could not be explained as static. However, through 3D molecules, animations and graphic, it becomes possible to show how chemical reactions take place, both at the macroscopic and the molecular level, resulting in the incorporation of attractive chemistry in action.

3. Using Information Technology (IT) to Enhance Teaching and Learning Chemistry

This article will focus on some methodologies that enhance teaching and learning chemistry through the use of IT; e-learning, virtual class rooms, video streaming, and self-paced education, Satellite; Videoconferencing, and m-learning.

3.1.E-Learning

Over the past few years, education has been improved by rapid developments of the ICT. There is an increasing demand for both web-based courses and for additional online materials to supplement and enhance classroom learning (blended learning). As a result, the availability of E-learning options has become an essential component of educational ability to attract students. E-Learning is a tool for designing new learning technique at anyplace or pace (24/7) using ICT. E-learning becomes a powerful recruitment tool, particularly for global education, and empowers teaching and learning science in general, and chemistry in particular. It enhances the understanding of scientific concepts through providing rapid access to knowledge and information.

3.2.Empowerment of Chemistry Education using E-Learning

The purpose of e-learning is the dissemination of information about the uses of technology to enhance teaching and learning chemistry and to stimulate discussion on these issues within our learning community. E-Learning makes education available at any place and pace.it also allows collaboration discussions between students and instructors and among students themselves synchronously through virtual classrooms, streaming videoconferences, video-conferences, white boards, etc., or asynchronously through self-paced education, forums, online education, e-mailing,

bulletin boards, etc.

3.3.Advantages of the Virtual Classrooms:

While current research shows that asynchronous online learning can be as effective as a traditional classroom, I found that addition of synchronous interaction in a blended environment provides significant advantages in teaching and learning chemistry.

In these methodologies, we are teaching chemistry, techniques and skills that chemists use out in the real world. Synchronous e-learning allows students to interact with computer modeling programs while they are in class. Students will be able to present sketches, graphs and drawings on the course Web site, download the files when they get to class, and also improve collaboration between professors and student, and among students themselves.

The most advantage of the virtual class room is the ability of the instructor to view those files synchronously, while students are still working, unlike a traditional paper notebook which would have to be turned in after.

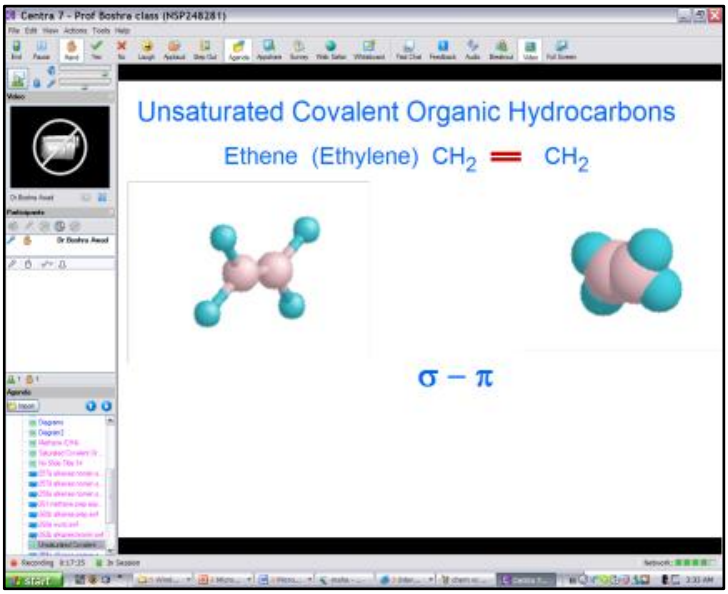
3.4.Impact of Using ICT on Teaching and Learning Chemistry

Chemistry study requires a lot of memorization. The ideas and concepts that are developed during E-learning can be captured by the students and help to broaden their understanding of the theories, reactions, and mechanisms presented. Many approaches to this is the enhancement of teaching chemistry, through guided inquiry, 3D molecules, equations, graphics, animations, quizzes, etc., which have been developed to help increase student participation in classroom activities with the goal of increasing their understanding and skills. Also e-learning helps in teaching and learning green chemistry, educational materials, including laboratory exercises,

course syllabi, lecture demonstrations, case studies, lecture content, textbooks, and interactive learning modules could be presented using new technologies (Multimedia, CDs, web-enabled content, video-conferencing, etc.).

"Good teaching is good teaching, no matter how it's done". E-learning proves to be flexible, provides content synchronously (virtual classrooms), asynchronously (self-paced), or blended. It allows content to be available and convenient for everyone at any place or pace, 7/24. It enhances teacher's skills and performance and student's understanding, decision making and problem solving. It allows interactivity and collaborative discussions, assessments, assignments, through forums, virtual classrooms, e-mails, white board, blogs, repository etc. It is designed around the learner, fosters greater student interaction and collaboration and also student/instructor contact. Enhances computer and Internet skills, and eliminates geographical barriers and allows broader education options. The most important impact is to attract students to study chemistry. It allows also teaching of green chemistry which is basically the design of products and processes, with reduction or completely elimination of hazardous substances in order to reduce the amount of pollution reactions produced.

The most important impact of using E-learning in teaching and learning chemistry was verified by the high attraction of students to register in the courses of chemistry and studying them with great satisfaction and getting high scores with achievement of deep understanding.



Virtual Classroom

3.5.Key Issues for High Quality E-Learning

To create an attractive high quality e-learning, we should take into consideration the following:

1. High quality successful web-based course.
2. Appropriate Learning Management System (LMS).
3. Successful online instructor.
4. Successful online student
5. Successful virtual classroom
6. Appropriate technology; information and communication technology (ICT) and computer networks.
7. Complete Integrated Solutions.

3.6.Disadvantages of E-Learning

The most notable disadvantages of e-learning are:

1. Lack of face-to-face interaction between students and teachers.
2. Expensive Web and software development
3. Lack of security, copyrights and policies
4. Lack of Infrastructure
5. Minimal interpersonal conduction
6. Some health and social problems

4. Improvement of Chemistry Education through M-Learning

The mobile technology that our students are using every day, 24 hours-a-day, deserves some consideration for potential use to help students learn chemistry. Use of mobile phones and tablets as a medium for learning is defined as M-Learning. This can be achieved by the use of mobile and portable devices such as PDA, cell phones, portable computers and Tablet PC. They must have the ability to connect to other computer devices, to present educational information and to realize bilateral information exchange between the students and the teacher. Mobile learning (m-learning) offers a whole new concept of learning for those who want immediacy and real interactive learning opportunities. M-Learning must include the ability to learn everywhere at every time without permanent physical connection to cable networks.

Regardless of existing disadvantages till now, the m-Learning will became more and more popular with the progress of information and communication technologies. Its common use with the traditional education will correspond to the needs of educational quality improve. The

educational process will become more flexible and will fulfill to the needs of lifelong learning. M-Learning also can assure good educational opportunities for disabled people.

4.1.How Can Apps Improve Teaching and Learning Chemistry?

Apps are application software designed to run on smart phones and other mobile devices. The Apps provide new ways of interaction with information. Interaction happens anytime, anywhere, with anyone or anything. The challenge to teachers is how to take advantage of the Apps, in the context of the course, to help students learn chemistry.

Apps that provide lessons on reactions mechanisms and stoichiometry and reaction animations are highly attractive and appreciated by students. There are Apps with lots of exams with difficulties ranging from easy to hard and include answers for each.

There are Apps that can be used to edit and build molecules in 2D and 3D, others with screen casts for analytical chemistry calculations of molarity and dilutions, games for experiments, dictionaries of chemistry terms, and titration simulators. Others provide features to perform complex calculations on topics ranging from gases, solutions, thermodynamics, electrochemistry, and acids and bases.

Regardless of existing disadvantages till now, the M-Learning will become more and more popular with the progress of information and communication technologies. Its common use with the traditional education will correspond to the needs of educational quality improve. The educational process will become more flexible and will fulfill to the needs of lifelong learning. M-Learning also can assure good educational opportunities for disabled people.

However, M-Learning has some pros and cons:

PROS: Flexible and affordable, since most students have their own device, portable, “anywhere,

anytime" learning, enables a personalized learning experience, allows immediate feedback.

CONS: Some students do not have a phone, classroom distraction, Potential for unethical behavior (cheating), privacy concerns, health concerns, raise questions about how to evaluate, lack of competence.

4.2. Pedagogical Implication of M-Learning

Helps to break down the financial and mobility constraints of learning.

- Provides learners with instructional materials and interaction whenever or where ever they need it.
- Allows instructors to access services and interact with students while on the move.
- A flash-based mobile interface is now being produced for m-Learning.
- Instructors should adapt to the m-learning environment whenever it is appropriate.
- Helps teaching and learning chemistry in rural areas and disables, etc.
- Allows the borderless enhancement of teaching and learning chemistry in the Middle East.
- Supports students and teachers (administrative tasks, etc.).
- Mobile learning would not replace traditional, online, or distant learning.
- Engages students that are addicted to their mobile devices in chemistry education

4.3. Technical Delivery Support for Mobile Learning

- 3GP for compression and delivery method of audiovisual content associated with Mobile Learning
- GPRS mobile data service, provides high speed connection and data transfer rate
- Wi-Fi gives access to instructors and resources via internet

- Cloud computing for storing and sharing files
- Authoring
- Learning Mobile Author e.g. for authoring and publishing WAP, Java ME and Smartphone

4.4. Technical Challenges of M-Learning

- Connectivity and battery life
- Screen size and key size
- Meeting required bandwidth for nonstop/fast streaming
- Number of file/asset formats supported by a specific device
- Content security or copyright issue from authoring group
- Multiple standards, multiple screen sizes, multiple operating systems
- Reworking existing E-Learning materials for mobile platforms
- Limited memory
- Risk of sudden obsolescence
- Lack of M-Learning tools
- Temptation to hit the new HTML5 publish button that allows the existing desktop courses as they are for E-Learning, and make them available for M-Learning

4.5. Future Technology for M-Learning

1. Processors in mobile devices will get faster
2. Connections will become more ubiquitous
3. The right infrastructure will provide Wi-Fi everywhere in the most cities in the near future
4. As for the batteries in our smart phones, they will last longer or better yet, can be replaced

all together by solar power technology

5. New tools are required for mobile learning, including a new mindset, new templates, simple, yet powerful and beautiful, that can display these learning experiences in a personalized way and on every screen
6. Start thinking mobile-first and then go back to desktops and apply the simplicity that is derived from embracing mobile constraints that come with smaller screens

5. E-Learning versus M-Learning

Figure 3 shows that both E-learning and M-learning can be used in enhancement and development of chemistry teaching and learning. M-learning outweighs E-learning in its simplicity, availability, and mobility.

Fig. 3. Comparison of E-vs. M-Learning

6. The Pitfalls of M- and E-Learning

- Lack of Security and policies
- Minimal interpersonal interaction
- Lack of Infrastructure
- Shortage in resources (HR, Funding, etc.)
- Lack of well-articulated flexible content

7. Ten Easy Steps for Successful E- and M-Learning Strategy

Figure 4 represents the different methodologies that attract and empower teaching and learning chemistry

1. The needs for the E- and M-learning should be defined
2. The technological Infrastructure should be established
3. Development of e-content according to the International standards
4. E-content should match the curriculum
5. Storyboard of the e-content is well-articulated
6. Teachers and students are well trained
7. Uncorrupted delivery of the e-content is assured
8. Team of the E- and M-learning developers are professionals
9. Evaluation of using E- and M-learning
10. Sustainability of the system

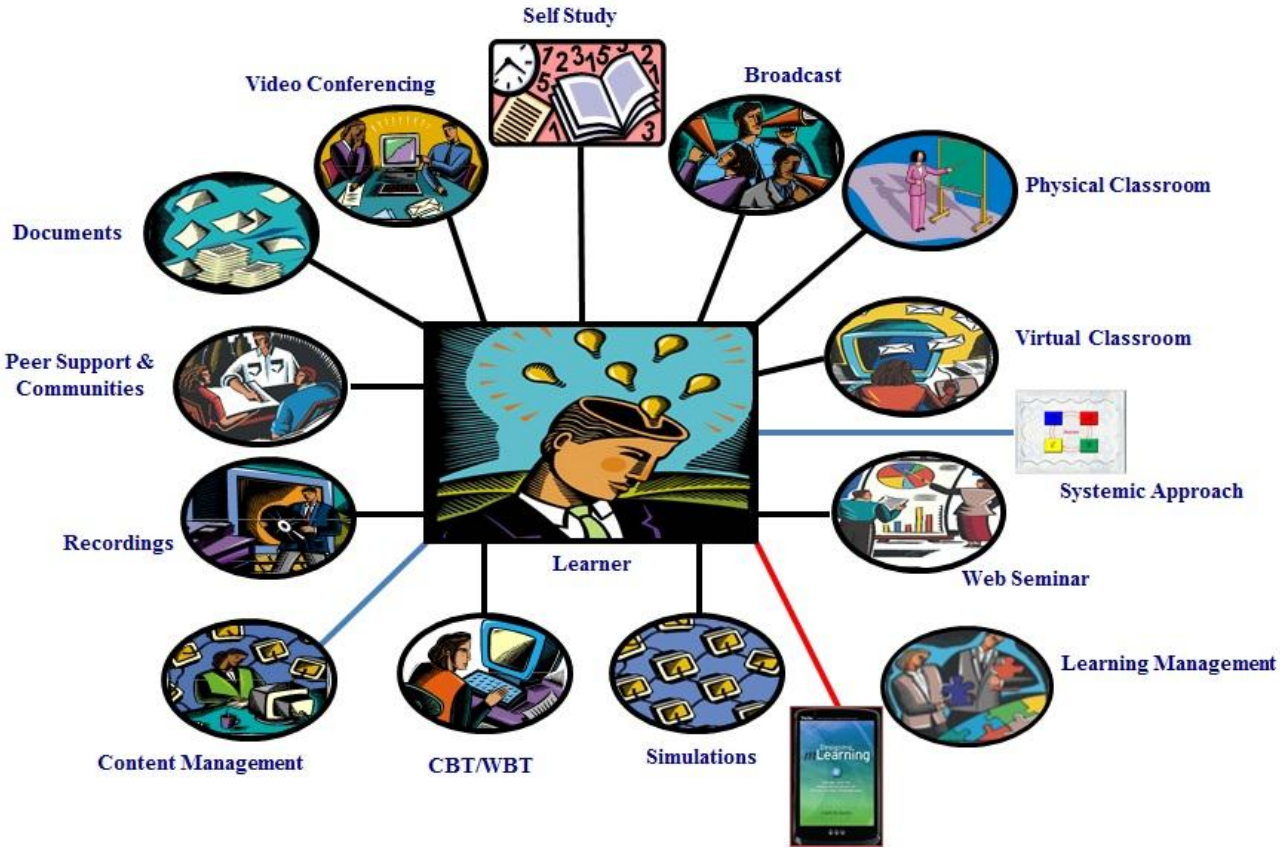


Fig. 4 Different strategies and methodologies in teaching and learning Chemistry

REFERENCES

1. http://www.differencebetween.net
2. The Systemic Approach to Teaching and Learning [SATL]: A 10-Year Review,A.F.M. Fahmy, J.J. Lagowski, AJCE, 2011, 1(1)
3. A. F. M.Fahmy and J. J. Lagowski "Systemic Approach in Teaching and Learning Aliphatic Chemistry: Modern Arab Establishment for printing, publishing; Cairo, Egypt 2000.
4. A. F. M. Fahmy and J. J. Lagowski, Systemic Approach to Teaching and Learning (SATLC) in Egypt. Chem. Educ. Internat. 3, AN-1, 2002.
5. A. F. M. Fahmy, M. H. Arief, and J. J. Lagowski, Systemic Approach to Teaching and Learning Organic Chemistry for the 21st Century. Budapest: Proceedings of 16th International Conference on Chemical Education, 2000.
6. A. F. M. Fahmy, A. I. Hashem, N. Kandil, "Systemic Approach in Teaching and Learning

Aromatic Chemistry" Science Education Center, Cairo, Egypt 2001.

7. A. F. M. Fahmy and M. El-Hashash "Systemic Approach to Teaching and Learning Heterocyclic Chemistry, [9th IBN Sina International Conference on Pure and Applied Heterocyclic Chemistry, Sharm El-Sheik, Dec. 11-14, 2004].
8. A. F. M. Fahmy, and M. El-Hashash "Systemic Approach in Teaching and Learning Heterocyclic Chemistry" Science Education Center, Cairo, Egypt 1999.
9. A. F. M. Fahmy and M. El-Hashash, Systemic Approach to Teaching and Learning (SATL). Proceedings of the 2001 International Conference on Heterocyclic Chemistry (Jaipur, India). Jaipur: RBSA Publishers, 2004.
10. A. F. M. Fahmy, M. A. Hamza, H. A. A. Medien, W. G. Hanna, M. Abdel-Sabour, and J. J. Lagowski "From a Systemic Approach in Teaching and Learning Chemistry (SATLC) to Benign Analysis, Chinese J. Chem. Educ. 2002, 23(12), 12 [17th ICCE, Beijing, August 2002].
11. Xia Zhou. Thinking towards teaching Physical Chemistry in China: How to increase the learning interest in this course. Retrieved October 7, 2010, from http://science.uniserve.edu.au/pubs/china/vol2/zhouxia.pdf.