

The use of a systemic approach in teaching and learning chemistry for the 21st century*

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INTRODUCTION

On reaching the next century and with the development of communication medias and the ease of information flow, the world seemed to be living in a small village full of developed and interacted information.

The new century generation have challenges that is difficult and numerous, either to find his place in this universe or the international flood of science and knowledge will take him away. So, it is a must to make a revolution in the methods of teaching. So that to create a recognized generation able to see what is going on around the world, and at the same time does not miss his identity. A generation able to forecast and be creative not the study and learn. A generation that is able to see the whole and not to miss some parts of it.

All that made us stop for a while and think a lot about our education reality, then ask if we want really an educational system reaching for requirements of the 21st century? or a system just to qualify the students for succeeding in exams?

We want as we are crossing to the 21st century to change our educational systems from linearity to systemic.

So we introduce here the Systemic Approach in Teaching and Learning Chemistry (SATLC) which means study of chemistry concepts through interacted systems in which all relationships between concepts are clear (Fig. 1).

Objectives of using the systemic approach of teaching and learning (SATL)

- 1 Growing the ability of students on thinking systemically: so that the student will be able to see globally any subject without missing its parts.
- 2 Growing the ability to see the relationships between things more than things themselves.
- 3 Increasing the effectiveness of teaching and learning chemistry.
- 4 Making chemistry subject attractive to students instead of being repulsive to them.
- 5 Growing the ability for analysis and synthesis to reach creativity that is the most important output of a successful educational system.
- 6 Creating a new generation that is able to work positively with environmental system around them.
- 7 Growing the ability for the use of systemic approach in acting with any problem to put the creative solutions for it.

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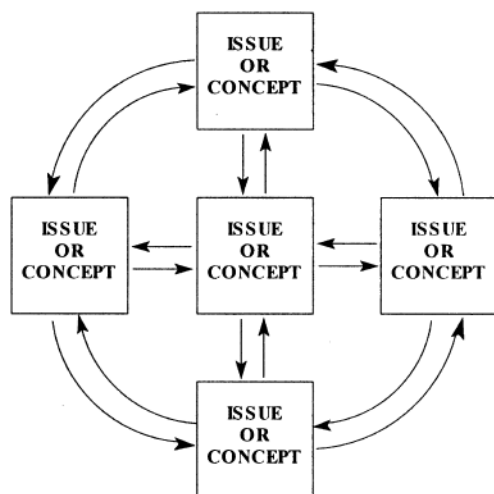


Fig. 1 Illustration of the idea of (SATLC).

Why systemic approach in teaching and learning

- 1 *We are living in the era of globalization in which we see the global Policies, Economy, Culture, Media, and Architecture, etc., is a reality constitute a new world system. so countries must hurry to prepare generations able to interact positively with the new international system. This means that it takes what is appropriate to it without missing its roots and identity. This positive interaction cannot be reached except by using new method that is to grow the skills of systemic creative thinking that sees the issues from multiple point of view or seeing interrelations between things rather than things.*
- 2 *It is important to say that the wrong human interaction in the environmental system without consciousness leads to the existing environmental problems. Here we have to stop for a while and ask a lot: why do the man behave like enemy towards his environmental system? Who is responsible about that? The answer is the educational systems that graduate generations interact linearly with the systemic environment.*
- 3 *The human body is an interacting system constitute at the end the balance that happens inside his body. In many times a man behave in a wrong manner harms his health such as taking drugs, and most of this behavior comes from shortage in our educational systems that prepare students linearly. So they interact with their body systems by the way they learn.*
- 4 *The world is suffering the terrorism and terrorism is now represents an international phenomenon threatening the economics and the security of the world. It begins by thought deviation then directed to behavior, and if we looked to terrorist at any place of the world, we find him as a graduate of educational systems teaching a lot and learning a little.*

But if man is equipped by systemic thinking in addition to the light of faith, we find him a constructive member in the society and not a destructive one, effective element in life system trying to reach luxury for himself and others. So we find that the best way of fighting the international terrorism begins by reform of the existing educational systems in most of the world countries.

For that we perceived, the necessity of **systemic directed teaching and learning** for the next century to prepare generations that is lightened and have the ability to interact systematically in the global era of international peace and cooperation.

This draws our attention to produce a new approach in teaching and learning (SATL) that enhances the systemic way of thinking.

Strategies of applying the systemic approach in teaching and learning (SATL):

- 1 Long-term strategy:

We begin it by entering (SATL) from the beginning of primary stage, then the preparatory stage, then secondary stage until the end of the high education.

But with the importance of this strategy, we have to wait for a graduate that his preparation takes from 16 to 18 years, in addition, it does not change the generations that are prepared or that are still prepared by the existing linear systems.

2 Short-term strategy:

In which changing the students from linearity to systemic takes place in any stage of education and in any subject of knowledge.

The advantages of the short-term strategies that the changes in the educational systems take place with higher speed to begin the next century with high ability to bear its challenges.

We see, that both strategies are needed and could be applied side-by-side.

So, we decided to begin with short-term strategy taking the General Chemistry in the secondary stage of education. As an example, we started with module of organic chemistry that is taught throughout the chemistry curriculum in the first stage of the general certificate. The second level module is about the organic acids and their derivatives. Its place is in the middle of the organic chemistry curriculum and by this it serves what is before and what is after.

We had met the following challenges:

- 1 Formulating this module by the systemic approach to meet the purpose of learning.
- 2 Changing teachers and their leaders from different levels of ages and experiences from the linear direction to systemic one in a limited period.
- 3 Experimentation on a sample of secondary stage students learned and tested by linear methods and this done two months before the final exam (General Certificate).
- 4 Convincing the educational authorities in the country (centrally and locally) by feasibility of the system in performance improvement of education.
- 5 Putting a systemic assessment that is accurate to measure objectives and be on the higher levels of education specially for analysis and synthesis.

These challenges have been overcome by a well-prepared plan.

Training of the teachers

There is a selection of 30 trainee of the teachers from different professional and experience levels (general inspectors, inspectors, senior teachers, teachers).

A condensed training program (theoretical and practical) on the systemic approach in teaching organic acids and their derivatives was held. The interaction of the teachers and their leaders (through the training) was incredible and there was enthusiasm and ability for the training. This was reflected on their performance during experimentation of the module.

Experimentation of the module

To illustrate the idea of (SATLC), we build up a module on carboxylic acids and their derivatives in the form of student text and teachers' guide. The experimentation of the module takes place in 8 classes in (6) Egyptian schools in big Cairo-Zone.

The duration needed for the experiment:

Seven lessons, theoretical and practical, distributed on two weeks in addition to tests at the beginning and at the end of the experiment.

The experiment began by zero point exam in all the schools and ended by the final exam. There was an encouraging conclusion reached from result of the questionnaire, its summary is that most of the students prefer the systemic approach in teaching and learning because its ease and shortness in time, intensify the

concepts, helps them in understanding and in study the rest of general chemistry, in addition, it is the most appropriate approach for the coming century.

The exam result and its highlights

- *The Percentage of success* was high in the experimental classes after experiment by a percentage more than the reference classes.
- *High percentage of the systemic direction* after experimentation in the experimental classes.
- Lower percentage of success in the reference classes before and after the experimentation.
- Higher percentage of high grade students after experimentation in the experimental classes (Table 1)

Table 1 Results of students in the pre- and post exams

Ser.	Type of classes	Total number of students	Total (%) of success	
			Before exp.	After exp.
1	Exp. classes	270	$= 75/270 = 27.77\%$	$= 217/270 = 80.37\%$
2	Ref. classes	159	$= 14/159 = 8.88\%$	$= 17/159 = 10.69\%$

By following up the experimentation in the schools, we observed the following:

- 1 Strong interaction between students and their teachers in the experimental classes in comparison with the controlled classes.
- 2 High performance of the systemic trained teachers in comparison with other teachers.

Statistical data of the (*t*-test)

Showed that no improvement in the student performance after experimentation in the controlled classes, however, there is a significant improvement in the student performance in the experimental classes as indicated from *t*-values (*t*-cont. 0.35, *t*-exp. 28.37). (also the mean of points (MP) in the controlled classes is nearly the same before and after experiment (29.74~29.42) and lower than (50). However, this is a significant change in the (MP) of experimental classes from 38.03 (before) to 63.18 (after) and becomes higher than 50 (Table 2).

What we have reached from the experiment:

From the reality of the experiment that was made in the schools we reach the following:

- 1 Entering the systemic approach for teaching and learning by one unit of general chemistry in a middle of the curriculum without causing any troubles in the students' way of studies in the rest of the curriculum by linearity. But, however, from the feedback it was of high benefit to the rest of the general chemistry units.

So we got an answer to the question from any subject we can start.

- 2 The application of the systemic approach in the middle of secondary stage (second level) without any problems or troubles to students or teachers or schools.

So we got an answer to the question from any stage we begin.

- 3 Teachers from different experiences, professional levels, and ages can be changed from linearity to systemic in a short period, and this change was in a high percentage after a condensed training program for them.

So we got an answer to the question who can teach this approach now.

Table 2

School code	No. of students	Mean of the points		Mean of difference	Standard of difference	95% Confidence interval of difference		(t) Value
		Before	After			Lower	Upper	
11EX*	31	45.75	76.45	30.70	10.40	27.01	34.38	17.01
12EX†	26	24.10	59.94	35.84	14.45	29.99	41.68	12.64
13EX†	47	47.27	63.28	16.00	11.70	12.57	19.44	9.38
14EX†	40	21.75	44.20	22.45	19.73	16.13	28.76	7.19
21EX*	51	32.65	60.33	27.70	10.76	24.66	30.71	18.37
22EX†	75	46.23	70.82	24.59	13.27	21.53	27.64	16.00
11R*	11	37.42	32.18	-5.00	19.16	-18.00	7.00	-0.90
12R†	13	27.95	28.42	0.47	11.47	-6.45	7.41	0.15
13R†	19	40.04	38.10	-1.90	9.70	-6.60	2.75	-0.87
14R†	31	27.87	21.79	-6.80	9.72	-9.65	2.50	-3.39
21R*	53	25.67	29.24	3.56	10.67	0.60	6.50	2.43
22R†	32	30.26	31.42	1.16	10.88	-2.75	5.08	0.60
Total ex.	270	38.03	63.18	25.15	14.56	23.40	26.89	28.37
Total ref.	159	29.74	29.42	-0.32	11.69	-2.15	1.50	-0.35

*Girls classes.

†Boys classes.

Std: Standard deviation.

Future looking

- 1 Systemic reform of the chemistry subjects.
- 2 Reforming of experimental skills to be appropriate with this methodology.
- 3 Reforming of teachers' training program.
- 4 Systemic reform of evaluation systems so that it reaches the levels of analysis and synthesis.
- 5 Do the same experiment at 1st year University level.

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