LEARNERS OBSTACLES IN SOLVING COMPLEX PROBLEMS SITUATIONS

ADJIBI HILAIRE
Institute of Mathematics and Physical Sciences, UAC Benin

hilaireadjibi@gmail.com

Basile AGBODJOGBE
Laboratory sciences of man and society (INJEPS of Benin)

Gabriel Y. H. AVOSSEVOU
Institute of Mathematics and Physical Sciences, UAC Benin

Kossivi ATTIKLEME
Laboratory sciences of man and society (INJEPS of Benin)

Introduction

School should not ignore that an individual is increasingly alone with himself and has difficulty to be oneself. To face this phenomenon, this requires developing new skills, ability to create, inovate to take charge. Finally, on reflection, life is only a result of solving problems, most of which have become complex nowadays. To this end, the resolution of complex problems, which require the development of suitable methods. This study has a double goal: to help teachers appropriating innovative methods to improve the efficiency of the Teaching / Learning / Assessment process of chemical technology and natural sciences and help students to organize for well develop a good plan of problem solving; we started by learners errors without worrying about the teaching conditions.

2- Methodology

To thereby, a survey of closed and open questions was sent to 450 teachers of chemical technology and natural sciences without distinction of level from the undergraduate to Ph.D. followed by an oral written interview with 30 teachers from this group to verify the accuracy of the answers given by those teachers to closed questions asked in order to build a genuine relationship between oral responses and those checked in the boxes on paper questionnaire. As for as students are concerned, it was administered to 246 students four exercises with two so called complex (with a bounding question) and two direct (where the questions are guided). The method adopted is to correct copies of learners; identify the number of addressed capacities; see successfully discussed procedures, the omitted ones and failed ones due to the mastery of mathematical necessary basic tools; conduct interviews with some students. This research begins with a theoretical approach to clarifying educational problems situations and the importance of problem solving in learning teaching process of chemical technology and natural sciences. We have produced results such as basic mathematical knowledge necessary for Chemical Physics Science and technology acquired by poorly applied students. These students lack of determination, purpose, planning, control and adjustment to discover and overcome obstacles. Also note a deficiency in methodology and knowledge of innovative methods for most teachers.

3-Theoretical approach

Problem solving is the cornerstone of learning. Learners are not only asked to build knowledge or expertise but to mobilize expertise act that allows them to solve complex and authentic situations. It is therefore necessary to understand the difficulties of students in problem solving and analyzing the impact of both cognitive variables such as the representation of the problem, mobilization and integration of procedures and motivational variables, emotional and metacognitive. In the other hand, attention should also be paid on the terms of effective interventions that would allow teachers to maximize the learning conditions of their learners around problem solving.

3-1- The term ‘‘problem situation’’ What is it?

According to Guy Brousseau, a situation is all the circumstances in which a person is, and relationships between him and the community.

From the perspective of didactics, a problem situation is experimental or theoretical situation in which the learner is placed on or in the end of learning. It is a set of contextual information to articulate for a specific task (ROEGIERS 2000). According ROEGIERS, it is organized by the teacher after a question or a riddle that arouses curiosity in the learner. It should create a problem which solution does involve emancipation, assumptions and tools, that is to say, techniques, concepts or resources already gained on order to lead to the discovery or new resources assimilation or the learning of the integration of these resources.

In view of the pedagogy of integration, ROEGIERS (2001) distinguishes between two categories of problem situations which the learner can face: the didactic problem situations and target problem situations.

Target problem situations correspond to the final skills already defined in the curriculum prescribed or output profile of the learner.

The didactic problem situations are used to learning resources. This design is similar to that of Yves ROEGIERS CHEVALLARD (1984). The latter defines a didactic problem situation as a teaching situation that enables learners to acquire screening of new knowledge (knowledge, skills and reasoning) and based on a socio-constructivist view of learning. Thus the new knowledge must be the unique solution of the situation. In such a situation, the learner decomposes the know ledge already provided for him and reconstruct it his way to personalize and contextualize it in his cognitive structure. The teacher plays the role of guide and facilitator.

3-2-What is an error?

- A cause of learners errors is the difficulty of an unrecognized problem by the Professor.

- A cause of learners errors can be relative to a rule of a teaching contract.

"The error is not only the effect of ignorance, uncertainty, chance that we believe in the empiricist or behaviorist theories of learning, but also the effect of prior knowledge, which had his interest, success, but which now is false or simply inadequate "(Brousseau, 1978)

The error can come from understanding instructions or difficulties of the learner to decode the implicit rules used when solving a problem. **For example:**

- For its resolution, do not extract data from the statement except those who are digital.
- All data are needed.
- If the answer does not fall on a single number that is we probably wrong.
- The problem has a solution and a single.

Before analyzing the procedures of learners, it is necessary to know the possible sources of errors. Students' errors are related to the various obstacles they encounter. There are three types of barriers:

- epistemological obstacle (knowledge pole) the nature of the statement is difficult to understand (specific to the learning task)
- didactic barrier (pole where the student and the teacher intervenes) teaching tools prevent from understanding (own to the choice of learners in their actions)
- ontological or psychogenetic obstacle (student pole) the age of the child prevents from understanding (own to the faculties of the learner)

Cognitive Self-Regulation

It is the individual's ability to plan and deliberately control their own cognitive processes. When solving a problem, determining the purpose, planning, control and adjustment are four major strategies that an individual can implement.

It appears in the light of our study that a disciplinary repertoire of knowledge sufficient for successful resolution of a complex problem in any way guarantee the success of this task. It must then have the ability to activate and use them in complex situations, which implies a supervisory structure and cognitive management of disciplinary knowledge directory. It is the self-regulation of cognitive strategies that support this supervision and this management. When solving a problem, determining the purpose, planning, control and adjustment are four major strategies that an individual can implement. The teacher should target the development of these skills in students during their course sequences.

- **The determination of the goal.**

During the tutorial sessions, the teacher should not be content to send a student to the board to expose its solution. He must get learners to determine the goal, the objectives to pursue and search procedures and strategies to implement before engaging in the resolution of the problem. For that he will invite them to read the statement of the problem to understand clearly and make appropriate representation to capture relevant information to put in link with their disciplinary knowledge.

- **Planning**

  Once the final state to reach and mobilize the procedures to mobilize determined, he must bring them to examine the possible resolution approaches and choose the one that is most suitable. These procedures and processes are recovered in the realization of previous similar goals. Then, he will invite them to determine the order in which these procedures should be performed, that is to say, to build an action plan that seems most relevant and most effective for the intended purpose. Finally, he will invite each of them to implement the action plan adopted.

- **Control**

While in the process of executing the action plan, the teacher will ask the learners to monitor and evaluate the process of the action they are waging and results. It would have previously explained the different types of control they would be led to:

- **Monitoring** which is a kind of conscious or unconscious permanent monitoring that triggers a warning signal when they realize that the course of business does not lead where it was expected or transient results differ from what was expected.

Monitoring indicates that there is not a clearly defined problem while the other controls identify a specific error.

- **Controlling** the realization of the aim: it is to confront the current action for purpose and to ask "is this really what I need to do to achieve the goal?"
- **The revision of the steps taken**. It is to ask, not whether a procedure was conducted properly, but rather whether it was conducted with reason. It is done on the basis of disciplinary knowledge and aims to assess the adequacy of the procedures performed.

- **Verification of results** is a periodic check which is done on the basis of knowledge of procedures and sought to identify the errors in the application of procedures.

➢ **The adjustment or control strategy**

It is based on the type of control used. The teacher will ask students to use the information obtained during control strategies to adapt its actions and allocation of resources.

The teacher will give as advice to his students to frequently use the problem solving strategy every time they have to solve a complex problem which approach does not jump immediately to the eye and to avoid precipitation in these kinds of task.

He may program over the year, several learning sessions of problem solving where this learning strategy will be systematically implemented and assess its impact on the performance of learners. During his meetings he will ensure to suggest problems that are really thinking and help students follow the suggested approach, such as: determining the purpose, planning, control and adjustment to discover and overcome obstacles.

In solving a problem, the most important phase is the representation of the statement, because it is what will allow the activation of procedures to be implemented in the long-term memory through the information that it will allow to send to the working memory.

Teachers should emphasize the need for a careful reading of the statement to collect relevant information and to put in link with the goal. This will break the problem into sub problems and the breakdown of these sub problems in other sub goals gradually will bring the procedures to be used. Several tools can then appear and the teacher will bring students to build from these tools resolution track. This track will have a probability of being found if the teacher encourages students to constantly ask two questions: What do we know? What are we looking for? Once this track and procedures are defined, the planning process can then start.

4-Results and Discussion

Factors responsible for the difficulty of students in solving a complex problem

Where does the difficulty of students in solving complex problems come from? The answer to this question will be known after the copies of students subjected to the so-called complex problems have been marked. We designated by X students' ability to get a good representation of the complex problem, to plan, to properly execute mathematical procedures of base and support cognitive overload and Y their difficulty in solving the complex problem. We have also identified indicators which measures the x and y will quantify X and Y and demonstrated the existence of a function f: x y = f (x) which appearance will indicate the possible influence of X on Y. Our task is now to build the f curve to test our hypothesis (H) **(the lack of adequate representation of the problem, the inability to properly plan and execute the basic procedures, cognitive overload are factors that explain the difficulties of students in solving complex problems)**. x is the score obtained by a student by assessing his ability to get a good representation of the problem, to plan, to correctly perform basic mathematical procedures and to contribute to cognitive overload following the standard set in the methodology and there is average notes (notes obtained by evaluating the format competency approach capability to mathematize, analyze and operate) students having obtained as x performance. x varies between O and 35 while y varies between 0 and 20.

To better explain the different results analyzed and presented before we performed other types of statistics according to the medium and the number of capacities addressed by the staff. This allowed us to obtain the following different argued curves.

Graph N° 1

The total workforce of students is assessed is E_{tot} = 246. The average of these 246 students are arranged in ascending order in the table below. These averages are grouped by class of amplitude of a = 2 rating.

n_i is the number of students who obtained an average in the range of order i notes. Table N°Z shows the statistical distribution of the workforce.

Averages grouped by class	workforce n_i	increasing cumulative enrollment	decreasing cumulative Staff
0-2	10	10	246
2-4	30	40	236
4-6	60	100	206
6-8	72	172	146
8-10	74	40	212
10-12	24	236	34
12-14	10	246	10

Table N°Z: Statistical distribution of numbers of pupils based on averages:

- **Determination of median average calculation**

The statistical distribution of the column croissants actual aggregated table N°Z shows that:

- 100 students have an average of less than 6/20
- 172 students have an average of less than 8/20

- The average should be the average of the 123rd student or the student occupying a rank r_o corresponding half of the number of students assessed.

$$r_o = \frac{E_t}{2} = \frac{24\ 6}{2} = 123 \qquad (2)$$

The number 123 is between 100 and 172, so there is 172-100 = 72 students whose grades are in the range [x, y] with x = 6 and y = 8. To give a more accurate result, it is assumed that the notes are distributed uniformly over the range 6 to 8. Each of these 72 students occupied in the range [6; 8] a measurement interval a_o such as:

$$a_o = \frac{y-x}{172-100} = \frac{8-6}{72} = \frac{2}{72} \qquad (3)$$

The 123rd student, counted from the beginning of the picture, holds in this interval the rank $r_o{}' = 123 \quad 100 = 23$. There are in fact 100 students who have less than 6/20. The hundred and twenty third student in question (123rd) will have a score n_o as:

$$n_o = x + a_o . r_o' = 6 + \left(\frac{2}{72} \times 23\right) = 6 + 0{,}64 = 6{,}64 \qquad (4)$$

We will retain $n_o = 6.64$ as median $M_{éd}$ rating of 246 students.

$$M_{éd} = n_o = x + a_o . r_o' = 6 + (8-6) \times \frac{123-100}{172-100} = 6{,}64 \qquad (5)$$

- **The median average of graphic determination**

To graphically determine the median, you must first build the curve corresponding to the cumulative effective growing and then search for the intersection of the latter with the parallel to the x-axis led by the coordinate point $(0;\ r_o = 123)$ when using the ordinate axis of actual aggregated. The horizontal axis of this intersection gives the desired median score. To this end, the diagram in figure N° G below shows the results.

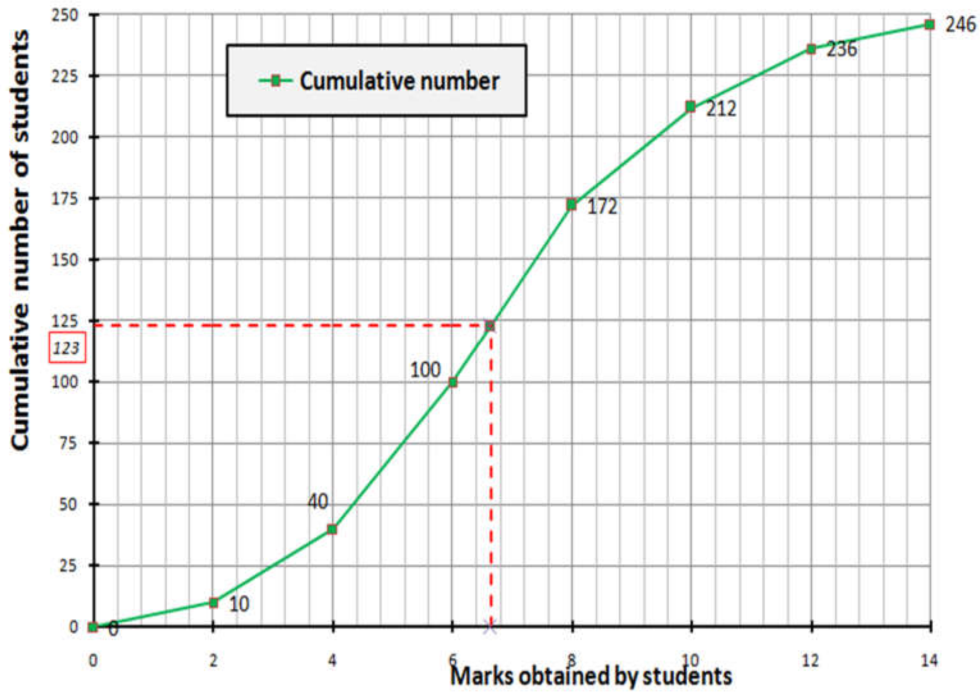


Figure N° G: cumulative enrollment of students based on grades*

The evolution of this curve shows that:

- ✓ The median average sought is $M_{éd} \approx 6{,}7$ and confirms that determined by calculation. This median characterizing the representative average level of those students tested is less than ten out of twenty ($M_{éd} < 10/20$).
- ✓ The number of students who obtained an average in the range of notes [0; 6.64] is about one hundred and twenty three (123) students (50% of total staff)
- ✓ Students whose averages belong to the range of notes $[0; 6{,}64]$ are eighty nine (89) so 36.18% of the total workforce
- ✓ Thus students who scored below ten out of twenty (10/20) represent 86.18% of the total number of students assessed. This diagram makes it possible to clearly show the low rate of student success, given the number of students who met a score below 10/20 in solving complex problems and the median average rating of this population.

Graph N° 2

Let y_i be the score obtained by the student i $X_i$after tackling abilities. The average of students who approached capacity is $Y = \frac{\sum_i^n y_i}{N}$ where N is the number of students.

If the addressed capacities were all successful, we get the curve $Y_{ideal} = f(X)$. The shift observed at the ideal curve for X = 24 capacity is due to the fact that any student who would have succeeded X = 24 capacity representing 2/3 of thirty five (35) capacities would benefit from the development of criteria weighted rating on 5 points according to the scale 40/40 (or 20/20). The Y_{reel} translate curve the actual development of students' after tackling X capabilities. As for the curve Y_{ideal} -Y_{real}, it reveals the gap between observed Y_{ideal} and Y_{real}. If the fact of mastering a capacity sufficient to solve a problem situation Y_{ideal} - $Y_{réal}$ = 0. The diagrams in Figure N° F below show the variations of different curves described above.

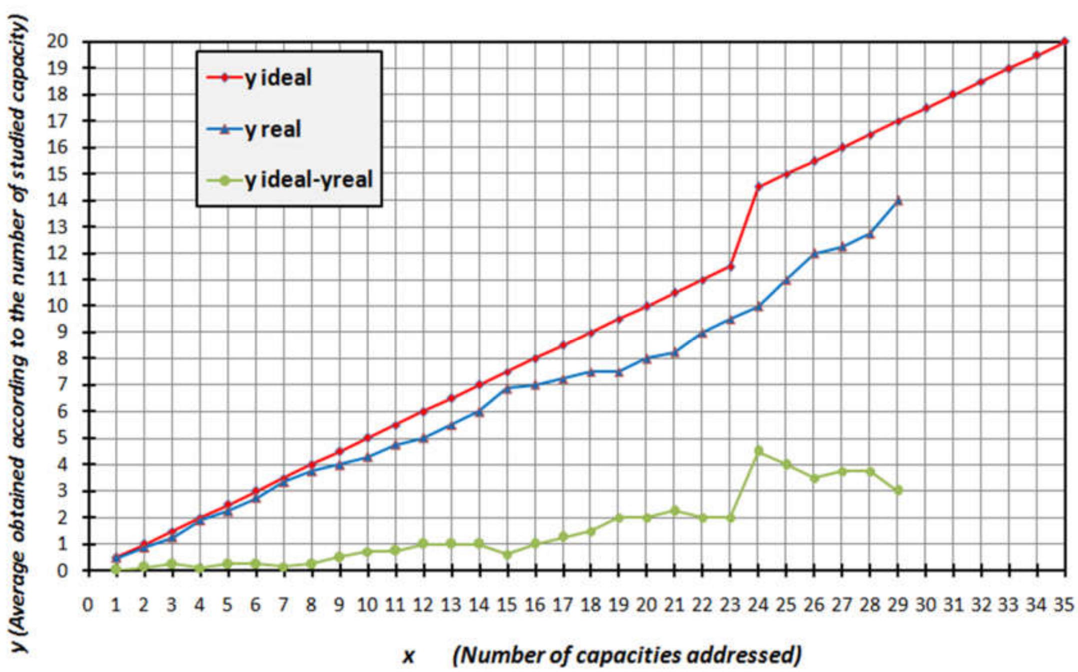


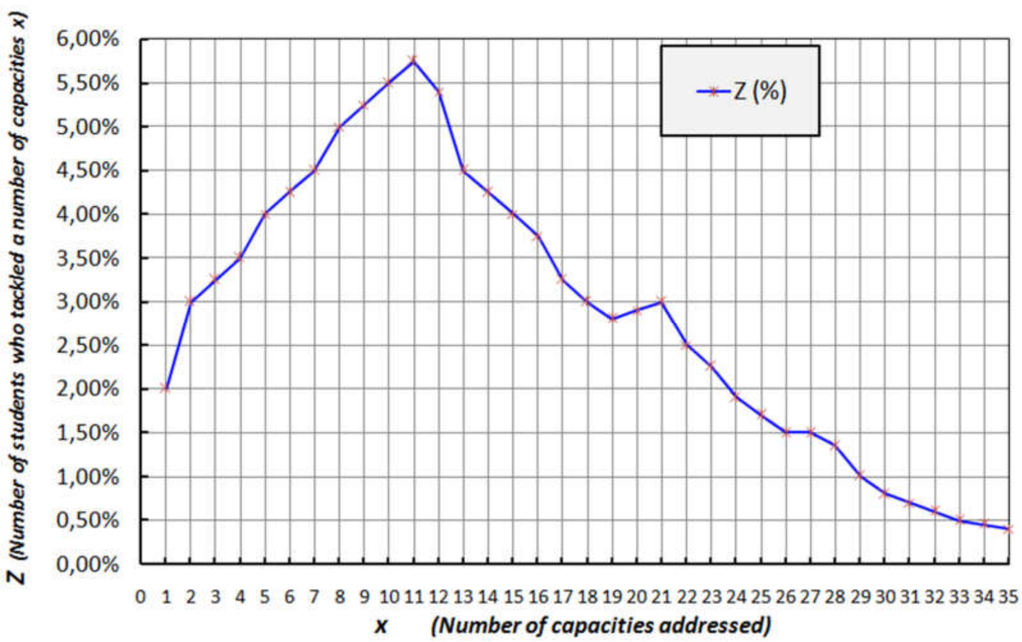
Figure N°F

The curve Y_{real}, which reflects the effort of the students succeed, to fail or abandon certain capabilities, shows that, as and when the number of addressed capacity increases, the student is facing difficulties. This can be seen through the stall the real curve compared to the ideal curve as $Y_{real} < Y_{ideal}$. Average decreases when the difficulties increase. This reinforces our hypothesis H as other factors, other than the mastery of basic mathematical procedures, may be the source of the failure of students.

The evolution of the curve Y_{ideal} - Y_{real} shows that it increases the number of $X \leq 24$ addressed abilities, but for numbers greater capacity to twenty four (X> 24), it suffers a slight decrease. This result confirms that the increase of capacities addressed accentuates the difficulties of students to solve a problem situation. If only the capacities were sufficient there would be a straight right to the image of Y_{ideal}. As Y_{real} is not a line, alone do not suffice for successful problem solving

Graph N° 3

Considering the number of capacities addressed by pupils in their resolution, we realized Statistics (measured in percentage) of the number of pupils who addressed a number X of capabilities. The resulting curve is as follows.



The student rate is 5.75% addressed 11 (eleven) building (see the pic that shows the graph 3). The conclusion here is that as the number of capacity increases (X> 11) the curve drops. This is evidence that in the progress of the capacity to address the difficulties increase causing a massive failure of students faced with solving complex problems.

Students are not only asked to build knowledge or know-how, and they have difficulties in mobilizing the know-how that allows them to solve complex and authentic situations. They are faced with computational difficulties and in the reasoning domain. They present difficulties related to the statement that is to say, understanding language, understanding the type of text, lack of familiarity with the context. They fail to sort the information, to diagram the problem, to explain what is meant. These students lack the determination of purpose, planning, control and adjustment to discover and overcome obstacles.

Students therefore do not happen to make a good representation of the statement. This phase is the most important because it will allow the activation of procedures to be implemented in the long-term memory through the information that it will allow to send to the working memory.

Similarly students in the vast majority have difficulty to understand the problem to solve, once as the successful step they often do not manage to make a good plan to finally execute well. They lack the ability to set a goal to reach though this objective formulation also poses a complex problem. We benefit greatly by applying to clear a goal to set before we start any problem solving. This would avoid experimenting with solutions that would lead to a dead end.

One can conclude that the average level of student difficulties in solving a complex problem depends on their ability to make a basic procedure and support cognitive overload.

The control of procedures base by a student to solve a complex problem in chemical technology and natural sciences, although necessary is not sufficient; other factors such as inadequate representation of the problem, the lack of good planning and proper implementation of these procedures as well as cognitive overload can lead the student to fail in this task.

5- CONCLUSION

The treatment of the didactic problem situation is ubiquitous in activities of chemical technology and natural sciences. As a process, the resolution of this problem situation is a learning object itself.

To achieve these goals through education of chemical technology and natural sciences, the format of the tests required to dress them which the contexts of the learner environment to get them to understand things, to manage information, organize data before discovering the substrate chemical technology and physics of these events. This tends to complicate the tests creates new difficulties: a student who has mastered all the basic procedures to solve a problem can fail in this resolution because of its complexity. Therefore it seems imperative to seek effective strategies to help students in this task. These strategies are metacognitive: self-regulation is an example. We proposed the problem solving learning based on four cognitive control strategies: determining the purpose, planning, monitoring and adjustment. In this process the representation plays an essential role. The objective of our research was to define a problem and the various stages of resolution. We also emphasized the inherent self-regulatory component in the problem solving process. Although the term self-regulation has its origins in the theories of metacognition, it can be compared with the assessment phase and monitoring developed in the framework of the theories of problem solving. This component seems crucial since it allows us to constantly challenge the actions of the learner. His mastery helps to make it more autonomous with regard to their learning. Learners, seeking to achieve their learning goals, must acquire, understand and master the concepts and knowledge they did not have initially.

Representations allow learners to better understand the relationships between the elements of a problem, to better understand their structure, brief to better define the problem.

The representations can take many forms; the important thing for the learner is to use a representation that he understands and that makes sense for him. Further analysis of the initial situation permits the use of another general strategy of constructing analogies. The person engaged in analogical reasoning essentially asks the following question: Does this problem look like the one you have already met? In doing so, he tries to assess if the problem looks like the one already known. He seeks to find how this problem is related to ideas and concepts that are found in its long-term memory. The more complex a problem is, the more numerous the opportunities to explore solutions are, and the more important planning becomes. However, faced with a complexproblem, planning is the best way to avoid fruitless searches and arrive with less effort to the ideal solution.

The planning stage can be divided into two sub-steps either, generate ideas of strategies or select a strategy.

The ability to remember the strategies already used is valid, but the ability to create new in front of an unusual situation is sometimes the only alternative. This step therefore uses creativity as it is possible to generate many and different ways of defining a problem that could lead to many solutions. From an educational point of view, it is better to train learners to generate several ideas for strategies rather than immediately apply the first that comes to mind.

An understanding of the processes involved in solving problems thus opens the way to interesting application for teaching.

Indeed, the teacher who focuses on the metacognitive functions, including self-regulation, allows the learner to become more adept in control of his own learning process. By becoming more autonomous, the learner comes to develop self-management skills of learning that will serve him throughout his life.

We must encourage the learner to understand what he does and to become active. These activities stimulate metacognitive learner, that is to say to get him to think about his own learning process and become more involved dealing with this process. This emphasis on metacognition though self regulation as wellas problem solving forecast to shift strategies and knowledge learned in school to other fields of knowledge.

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