# A LOOK AT CHEMISTRY LEARNING STRATEGIES AT SCHOOL

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## ABSTRACT

In this era called by some the industrial 4.0 era in the 21st century, a series of requirements arise that each individual needs to perform with economic and social solvency in society, one of these most important conditions is to have high-level thinking skills that can be useful and functionally applied in terms of building the society demanded by the 21st century. It is therefore logical to understand why thinking skills are a relevant and decisive component in the educational process. What is evident is that in order to achieve an accurate response to the demands of the 21st century, it is necessary and pertinent that knowledge is supported by the capacity for critical thinking, that it is assumed and projected in a creative way, and reaches an association that allows it to implement information and communication technologies (ICT). It is notorious that the teaching of chemistry has become a very complex task for teachers. On the one hand, the process of updating educational plans must be continuous in the profession. In such a way that the teacher needs an adequate planning, which includes the use of a language easy to understand for the students, facilitating the process of learning the explained contents, being an indispensable requirement the active participation of the student in the process as a way to guarantee the success of the teaching work.

**Keywords:** Teaching, chemistry, strategies

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## INTRODUCTION

Chemistry constitutes in secondary education, a subject that involves a high level of difficulty, which in addition to the cognitive of the student, is also a consequence of the teaching strategies of the same since traditionally these are repetitive and memoristic making it difficult to understand, and prolonging these difficulties not only in secondary education, but at university level of the study of this science, with its corresponding consequences for the scientific development of the country (Rodriguez E., 2013).

Although there is a diversity of factors and each of them has a series of dynamics, some such as the student's condition and the type of school, constitute critical variables that could influence the choice of the students' learning strategy, it is necessary to examine other components of the same educational process that can also show their own vigor, affecting the teacher's decision to achieve a relationship with the students through an adequate learning strategy.

## LEARNING STRATEGIES

For Beltran (2003), it is difficult to identify and diagnose the causes of low or high performance if the learning strategies used are not identified; since two people may have the same intellectual potential, have received the same teachings, instructions and motivations, but the quality of their learning and their academic results may not be equally successful; this is due to the differences implemented in their learning strategies. The importance of mastering technological skills and thinking skills, among which the adequate learning of chemistry is essential, given the advances in this field that humanity is experiencing. These factors are necessary as they contribute to students connecting concepts and materials that will be useful in any future performance in their professional life; but also to understand and solve problems in the learning process, where a person's ability to succeed both academically and at work is evidently manifested; since life is determined by the present demands of preparation and competence, among other things, by their ability to think.

For all these reasons, improving the quality of education is one of the main commitments of national governments. Undoubtedly, the selection of good classroom practice promotes effective classroom management, thereby achieving improved school performance in science education (Pawlak & Gross, 2019). It is precisely because of this, that achieving that the student population learns more and advances in knowledge and technique, to ensure better

living conditions, has become a discourse promoted from supranational entities such as the United Nations Educational, Scientific and Cultural Organization- UNESCO and the Organization of Ibero-American States - OEI. To achieve this goal, it is necessary to take into account the various factors that affect the development of student learning, such as their social, cultural and family conditions, the educational project of the institutions, the teaching strategies proposed by the teacher and their pedagogical skills, and the learning strategies undertaken by the students to facilitate their learning.

In the particular case of the teaching-learning process of chemistry, it is undoubtedly that much of the academic success rests on the learning strategies used by students, it is not enough to involve the student in a participatory activity since it is common that many students have difficulties in maintaining a good level, given that sometimes they cannot perform the observation well and lead to poor results affecting their proposed learning, this due to deficient knowledge and skills that fail specifically at the time of performing the correct observation and writing the results derived from this (Suciati et al., 2018). This strategy comprising observation as a means of learning, or as an instrument of learning, must be done using all the senses, for which it is required that they have been previously equipped oriented towards the desired pretension. Therefore, the strategy based on observation must be carried out closely to allow the senses to obtain correct data. When assessing the process and examining the quality of observation results, they are divided into two major classifications, namely scientific observation and trivial observation results (Subagia, 2013).

No less important in this sequence are the types of systems proposed to classify learning strategies, there is a wide variety and each one of them manifests interesting contributions; in the case of the classification of learning strategies proposed by Roman and Gallego (1994) using for this case the ACRA measurement instrument, they categorize four types of strategies which are; acquisition, codification, recovery and information support. In this classification, acquisition is the one that intervenes to establish the form that allows the learner to obtain new information through learning; its main value is methodological in the learning process. Meanwhile, codification is the one that relates the main ideas to each other and to the secondary ideas that are within the text. Within this same order of ideas, it corresponds to establish the mechanisms that will be used in the recovery of previous information, making it available for later use; in such a way that information support is the phase that is in charge of informing the conditions and resources that will be implemented at the moment of data

processing within the improvement of learning (Alvarez et al., 2008).

It is valid to consider the emergence of numerous studies and concepts in recent years, which have enriched the currents of study of learning, are the so-called neurosciences, mainly in: cognitive neuroscience, neuropedagogy, and finally neurolearning, The latter is identified as a valuable essential tool for the role of the teacher and any training process, where the manager has an instrument that guarantees success in its activity (Pherez et al, 2018). It is highly probable that, without giving significant responsibility to the irruption of neuroscience, it is not possible to advance conclusive analysis of components of the educational process.

According to this, there is no guarantee of a successful teaching-learning process in chemistry when there are doubts about the use and good use of observation as a learning strategy, without detracting from its value.

Here it can be pointed out that some of the main relationships between the educational strategy implemented and school performance, have been able to specify that the student, due to a set of characteristics both own and as a result of the interaction with others, learns to use learning strategies within a motivational environment characterized by freedom to use their acquired knowledge and strengthens autonomous learning, This has been demonstrated in studies by McCombs and Whisler (1989), where he highlights the meta-cognitive skills as a means of stimulating the processing, planning and regulation of learning processes, which has led to accept that human behavior when placed through motivations for the resolution of the needs of self-development and self-determination (Torres, 2020).

## OBSTACLES IN CHEMISTRY LEARNING STRATEGIES

One of the major obstacles to the teaching of chemistry, comes from the fact that students often struggle with misconceptions in science, these conceptual and theoretical deviations affect the learning of this subject that for reasons associated with human culture is so little motivating, some aids such as multiple choice tests work well to identify common misconceptions, and are an important starting point to remove them, and thus shield the teaching without these theoretical deviations can prevent or hinder the learning of scientific ideas. Repeatedly, many investigations have shown that most students have low performance in the area of basic science (Clement, 1982).

It is evident the existence of factors that are not directly linked to chemistry learning but influence the quality of it, these distorting elements are related to the educational offer of the system that governs the State or government where the formative events take place, the quality of the infrastructure, the contents, the characteristics of the students, but also the influence of contextual factors such as technological advances, the political climate, social and economic problems. Conditions can affect generational cohorts in different ways, but when learning is student-centered, student satisfaction undoubtedly predominates; through research, it has been found that active learning, which involves students participating in both *'doing'* and *'reflecting'*, is ultimately a critical factor related to effective instruction (Millis, 2012).

Since the learning of chemistry in high school is mainly oriented to the purpose of developing factual, conceptual, procedural and metacognitive knowledge, it is also very usual that during the learning process tasks for the formulation and application of concepts are provided (ICMSE , 2019). Which shows the importance of the theoretical and conceptual components that are inherent to this teaching, there are still those who consider that learning chemistry is eminently practical, leaving aside its conceptual requirements.

A factor already inherent to the teaching-learning process that can also distort the teaching of chemistry and affect a learning strategy comes from the teacher himself, since if he has inadequate skills in the knowledge of the content of his curriculum, he is likely to transfer the knowledge by mistake, which leads to an undesired result since the students can result with an unplanned knowledge of the content and it is here where the learning strategy is susceptible to present much deeper anomalies, among which doubt arises about the formative process itself. The role of the teacher must be in accordance with the learning needs, but also, take care of the quality of the educational content that is taught. The misconceptions about the basic ideas of chemistry will be supported in such a way in erroneous concepts or not related to the current subject matter. It is worth mentioning that students will not be empty slates when they arrive at new courses (Duit, 2014).

This variety of positions that compromise the pedagogical function can be explained if one considers that successful teachers consider these three aspects of teaching, i.e., develop subject matter knowledge, content standards, and subject-specific pedagogy (Lederman & Lederman, 2017); a much larger picture then already emerges that would consider actions to

improve the teaching process and complement with adequate learning strategies on the part of students; then the development and application of knowledge must have a close relationship with the variety of knowledge needs sought by students; research actions and direct learning are indispensable, as is also current and necessary the theory on how students learn, since it is an indicator that can improve reflective aspects and analyze the evidence of the effects of instruction on the specific learning of chemistry by students.

Through research and development, different methodologies have been investigated and constructed to model in students some learning strategy for high school chemistry, some of them are supported by the so-called beginning experiment approach, which is only one of the current trends. In a recent study conducted from the indicated approach, especially based on the idea of the starting experiment approach (SEA) which has been promoted mainly Schönherr and which is complemented by the components established in an abductive empirical learning cycle which is based on that proposed by Lawson (Subagia & Wiratma, 2020); the experience acquired with the implementation of this chemistry learning strategy, arises from an initial experiment which is given the function of introducing the subject matter, and subsequently through the lesson stimulates the curiosity of the students to learn chemistry, for which it is oriented to the use through the observation of a simple experiment. From there, they proceed to the construction of the knowledge of chemical concepts, which allow a connection with the macroscopic and microscopic phenomena of the subjects present there. However, the results of the research made it possible to establish the great difficulties of the students in learning chemistry.

Other research has been conducted in different places and over time with the purpose of showing the effectiveness of active learning and the role it plays as a motivator to achieve better performance of students in secondary grades in the subject of chemistry, which shows the importance of students adopting learning strategies that guarantee a good result, ssiendo that these are anchored to the actions it develops to make this learning possible, motivated by a set of emotions that drive such action, so says Meneses (2019) in the review he makes of the work of Francisco Mora.

An unequivocal sign of the importance of a good learning strategy in chemistry, comes from the interest from psychology, where there has been abundant literature on learning strategies, in practice the student is rarely placed in a process of critical reflection on the

activities he develops to achieve learning, understanding that learning strategies are not the same as the study techniques he uses (Beltran, 2003). Usually, when it comes to learning, the learner remains in repetition, as this is the method he/she also receives from his/her teachers, who in some cases encourage learning by reciting certain theoretical positions as the only truth (Romero, 2009), and little space is given to imagination, proposition and analysis.

One of the complaints stemming from almost two decades ago is that, in traditional chemistry classrooms, chemistry is often taught as aggregations of isolated facts, and students may experience chemistry without relevance (Gilbert, 2006). In this context, a teacher may be faced with the situation of having rethought and adapted his teaching strategies, and find that, in the end, few changes are evident in the performance of his students, since the problem may come not from this exogenous condition, but from within the student for not developing adequate learning strategies. As stated by Gonzalez and Diaz (2006), the efforts that can be made in learning strategies are more profitable academically speaking than in instructions and teaching techniques.

## COMPONENTS OF CHEMISTRY LEARNING IN HIGH SCHOOL

The learning strategy implemented is only one of the components, although it plays an important role in the whole scaffolding, but this learning strategy alone is not enough. Entin and Feather (1982), consider on this subject of the learning strategies, that the determinant are the objectives with which the influence in the learning behavior is projected having as attitude the student's attention, as also plays an outstanding element the promotion of development strategies, which, together with essential aspects such as the stimulus to creativity, the effort, the dedication for the fulfillment of the proposed activities. These factors are basic not only in the case of the subject of chemistry, they are extensive to any other teaching-learning process and therefore other components are required.

A requirement that also participates with great property in the learning strategies, and that comes from a vital need, is that these strategies require the implementation of an intentional teaching process, since they are not innate in the student, they are learned processes, through the development of cognitive skills. The best indicator of this is that when there are significant and positive improvements in the teaching processes, these are reflected in the acquisition of learning, being the relationship between these factors, which indicate the impacts of the new educational strategies that are assumed. For example, Ausubel (1963)

points out that it is a condition for meaningful learning that students are able to clearly establish significant relationships between the previous information they have acquired and the new information, so it is a condition to acquire, process and develop that information according to the objectives that have been proposed; being the means for this the learning strategies.

To this sum of required factors, it is necessary to add the one coming from the psychological component, whose postulates for education are of primary importance in this learning process, which is why learning theories basically come from psychology (Schunk, 1997). Many of the existing theories on learning essentially consider three variables at the time of research: a) the results (manifested in changes in behavior or mental processes); b) the means (the teaching-learning processes through which the changes are produced); and finally c) the factors that enhance or trigger learning (Driscoll, 2000).

But it is also necessary among other planned activities that can give effectiveness to the intended learning, among them are the strategies that are designed, the didactics and materials that are used, however, some characteristics of the student are equally decisive; From a look towards the education of the XXI Century, the important role of the student in the teaching-learning process stands out, given that the organizational aspects such as the study plans and the learning strategies that are applied are valuable for the formation, not less are the behaviors of the students. A combination of these factors will make it possible to successfully face the requirements of their studies and thus overcome the different expectations of the family and even the demands of society in their education. From this perspective, factors such as skills, problem solving, teamwork, entrepreneurship, autonomous learning, citizenship training, etc., challenge the intellectual processes assumed by this population (Garcia et al., 2015).

It is also a specific and essential factor, the application of metacognitive strategies, which are those coming from the word metacognition that corresponds to a compound term in which *"cognition"* means to know which is closely associated with learning, and also with the word *"goal"* which refers to the ability to know consciously; so metacognition comes from the precepts, to know what I know, to explain how it learns and even to know how it can continue learning (Flavell, 1979).

Some of the main relationships between the educational strategy implemented and

school performance, have been able to specify that the student, due to a set of characteristics both own and as a result of interaction with others, learns to use learning strategies within a motivational environment characterized by the freedom to use their acquired knowledge and strengthens autonomous learning, This has been demonstrated in studies by McCombs and Whisler (1989), which highlight metacognitive skills as a means of stimulating the processing, planning and regulation of learning processes, which has led to the acceptance that human behavior, when working towards the resolution of self-development and self-determination needs, unfolds more fully (Markus and Nurtus, 1987); Maslow, 1983).

It is necessary to take a look at the evaluator of any learning strategy implemented, and here it corresponds to examine the relationship that this has with academic performance. Baş, and Beyhan (2019) conducted a study in which the authors focus on the central objective of the examination and the relationship that may exist in terms of the effect of teaching learning and strategies on the academic performance of students, the lack of knowledge of this relationship and its effects, motivated the researchers to adopt in the study the meta-analysis model with the aim of carefully establishing the effectiveness of teaching learning strategies and their real impact on the academic performance of their students. They took as sources to investigate these effects, a set of published and unpublished empirical studies in Turkey, but having as a sieve of the selection process a set of criteria to include or not to include a certain study. Without adequate academic performance, it is not possible to point out the success of a certain learning strategy.

The abundance of researches that take as a reference point to evaluate certain learning strategy from the academic performance of students is copious. İlçin et al. (2018) developed a study to establish the relationship between learning styles implemented in Turkey to physiotherapy students and their relationship with performance. They delimited for this the concept of learning style by defining it as the unique ways in the formative processes that an individual processes and retains new information and develops new skills. In order to achieve a better approximation to the studied reality, they started from the learning styles of 184 physical therapy students, constructing a measurement scale that facilitated their determination by means of the Grasha-Riechmann student learning style scales.

It is also evident and deserves a separate chapter, the relevance of information and communication technologies as a tool to improve the learning of chemistry; although studies

on the subject are just beginning to emerge, it is noteworthy that there is the possibility that through mobile technology that students in much of the world use every day, 24 hours a day, and whose use in online learning strategies is perhaps one of the most significant advances in recent decades in the educational field, these technologies, deserves some consideration for potential use to help students learn chemistry. It also constitutes a means to move quickly from a teaching-centered to a learning-centered approach, as the possibilities with connectivity stimulate this type of learning, offering changes and innovations related to modernizing the structure of courses, developing other types of assignments, changing forms of student assessment (Omasheva et al., 2018) and getting continuous feedback.

It is therefore highly convenient to identify that the challenge of education systems in recent years has been to maintain the vitality of education on the one hand, and on the other, to promote meaningful learning without losing the pace of its massification. Meeting these goals in many countries has been the great educational challenge and therefore the greatest requirement for learning. The great responsibility of educational systems has had key allies in this purpose; teachers and computer tools, that is, teachers who, through the implementation of tools provided by ICT, opened the way to a new way of generating their own learning to work in virtual environments (Bonilla, 2020).

## CONCLUSIONS

Learning strategies are of definite usefulness for the development of the teaching-learning process in any area, but it has a particularity when implemented in the subject of chemistry, which comes from the double factual and theoretical sense of it.

After conceptually characterizing some of the definitions on the subject, it is concluded that learning styles have a determining influence on academic performance.

The existence of a diversity of psychological, social and economic factors that contribute to the low performance of students should be taken into account, so that the learning strategy implemented is one of these determining factors.

Based on this extensive availability of works from studies corresponding to many countries in the world, which take academic performance as the basis of their evaluations, this study serves to show the diversity of criteria, approaches and methodologies that can

be implemented when trying to decipher the relationship between learning strategies and academic performance in various subjects, but with a particular emphasis on the area of chemistry, the methodologies used, facilitate the construction of a set of previously elaborated concepts.

## BIBLIOGRAPHIC REFERENCES


- Ausubel, D. (1963). The psychology of meaningful verbal learning. New York: Grune and Stratton.

- Bas, G., & Beyhan, O. (2019). Revisando el efecto de la enseñanza de estrategias de aprendizaje en el rendimiento académico: un metanálisis de los hallazgos. Revista Internacional de Investigación en Educación y Ciencia (IJRES), 5(1), 70-87.

- Beltrán, J. (2003). Estrategias de Aprendizaje. Revista de Educación(332), 55-73. Obtenido de https://www.educacionyfp.gob.es/dam/jcr:0bc115bf-2ee5-4894-91f5-7e32e07059d4/re3320411443-pdf.pdf

- Bonilla, J. (2020). Las dos caras de la educación en el COVID-19. CienciAmérica, 9(2).

- Clement, J. (1982). Students' preconceptions in introductory mechanics. American Journal of Physics .

- Driscoll, M. (2000). Psychology of learning for instruction. Boston, MA: Allyn & Bacon.

- Duit, R. (2014). Teaching and learning the physics energy concept. Teaching and Learning of Energy in K12 Education .

- Entin, E., & Feather, N. (1982). Attribution to success and failure in contingent and noncontingent paths. Washington, DC: Hemisphere.

- Flavell, J. (1979). Metacognition and Cognitive Monitoring. American Psychologist, 34(10), 906-911.

- García, F., Fonseca, G., & Concha, L. (2015). Aprendizaje y rendimiento académico en educación superior: un estudio comparado. Revista Electrónica "Actualidades Investigativas en Educación, 15(3), 1-26.

- Gilbert, J. (2006). On the nature of 'context' in chemical education. International Journal of Science Education, 28(9), 957–976.

- González, D., & Díaz, Y. (2006). La importancia de promover en el aula estrategias de aprendizaje para elevar el nivel académico en los estudiantes de Psicología. Revista Iberoamericana de Educación, 40(1), 1-17. Obtenido de https://dialnet.unirioja.es/servlet/articulo?codigo=2098498

- ICMSE . (2019). Sexta Conferencia Internacional sobre Matemáticas, Ciencias y Educación . Journal of Physics: Conference Series

- İlçin, N., Tomruk, M., Yeşilyaprak, S., Karadibak, D., & Savcı, S. (2018). The relationship between learning styles and academic performance in TURKISH physiotherapy students. BMC Medical Education.

- Lederman, N., & Lederman, J. (2017). J. Sci. Teach. Educ.

- Markus, H., & Nurtus, P. (1987). Possible selves. The interface between motivation and the self-concept en K. Yardley y T. Honess (Eds.), Self and Identity: Psychosocial Perspectives. New York: Wiley.

- Maslow, A. (1983). The farther reaches of human nature. London: Penguin.

- Mc. Combs, B., & Whisler, J. (1989). The role of affective variables in autonomous learning. Educational Psychologist, 24(3), 277-306.

- Meneses, N. (2019). Neuroeducación. Sólo se puede aprender aquello que se ama, de Francisco Mora Teruel. Perfiles educativos, 41(165), 210-216. Obtenido de https://doi.org/10.22201/iisue.24486167e.2019.165.59403

- Millis, B. (2012). Active learning strategies in face-to-face classes. IDEA.

- Omasheva, A., Sugralina, L., Minayeva, Y., & Salkeeva, L. (2018). Implementation of Active Learning and Assessment for Chemistry Courses. The Eurasia Proceedings of Educational & Social Sciences (EPESS), 10, 77-84.

- Pawlak, F., & Gross, K. (2019). Using classroom management to support inclusive chemistry learning. The Beauty and Pleasure of Understanding: Engaging with Contemporary Challenges Through Science Education, 359–366.

- Pherez, G., Vargas, S., & Jerez, J. (2018). Neuroaprendizaje, una propuesta educativa: herramientas para mejorar la praxis del docente. Civilizar Ciencias Sociales y Humanas.

- Rodríguez, E. (2013). El aprendizaje de la química de la vida cotidiana en la educación básica. Revista de Postgrado FACE-UC, 7(12), 363-373.

- Román, J., & Gallego, S. (1994). Escala de Estrategias de Aprendizaje, ACRA. Madrid: TEA Ediciones.

- Romero, A. (2009). La Dinámica de la Instrucción en el proceso educativo. Investigación Educativa, 13(23), 129 - 136.

- Schunk, D. (1997). Teorías del aprendizaje (2ª ed). México: Prentice-Hall.

- Seemiller, C. (2021). What makes learning enjoyable? Perspectives of today's college students in the U.S. and Brazil. Journal of Pedagogical Research, 5(1).

- Subagia, I. (2013). Pros. Semin. Nas. Undiksha : MIPA.

- Subagia, I., & Wiratma, I. (2020). La eficacia de la estrategia de aprendizaje de química para mejorar el proceso de aprendizaje y los logros de los estudiantes. Serie de conferencias Journal of Physics.

- Suciati, A., Imaningtyas, C., Anggraini, A., & Dermawan, Z. (2018). Pendidik. Indones: IPA .

- Torres, A. (2020). La relación de liderazgo entre las teorias de liderazgo situacional y la acción humana. Navarra: Universidad de Navarra.