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Abstract	This work implements the use of the "Educa Plus" platform to achieve interactive and meaningful learning in the field of chemistry. The research is developed through an analysis that combines quantitative and qualitative methods, using a conceptual framework and research variables within the educational field. These variables are examined through a study that includes a statistical analysis with the aim of analyzing the factors involved in the pedagogical methodology. The main purpose of this article is to present a concrete proposal: a manual of activities that improves the teaching-learning process through the use of technology and the promotion of teamwork. The intention is to provide educators with practical tools that allow them to make the most of available technological resources and create a collaborative learning environment.

Keywords (separated by '-')	interactive learning - virtual platform - learning and teaching optimization

Methodological Actions for the Electronic Configuration of the Educa Plus Platform: Promoting Interactive Learning

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Keywords: interactive learning · virtual platform · learning and teaching optimization

1 Introduction

The traditional educational process teaches in a unidirectional way where the teacher is in charge of the transmission of content and the student, who has a passive attitude, learns it. Over the years, the teaching-learning process has been changing and seeks to awaken certain qualities or abilities in the student to obtain knowledge more efficiently. Students should have an interest in what they seek to learn, they should use their imagination, creativity, experiences and prior knowledge for meaningful learning. "Learning has evolved from acquisition/accumulation of knowledge to a more complex one, where knowledge

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is built mediated in a social and cultural environment. This implies modifications in the cognitive structures of the student" [1]. Therefore, the introduction of innovative and interactive educational approaches is required to address this new paradigm.

The digitalization of education in the twenty-first century has led to a meaningful learning approach that transcends mere memorization, leaving behind the traditional scheme of vertical and unidirectional teaching that seems to isolate both teacher and student, in a dynamic, interactive, and attractive learning [2]. Consequently, teaching must be adapted to promote skills that allow the application of the knowledge acquired through the analysis of real situations that involve decision making, observation and the use of technology. At the Baccalaureate level, the subject of chemistry is fundamental, students must acquire basic knowledge in this area to avoid difficulties when starting a university career related to science. In addition, it is important to encourage scientific thinking in students that will help them in the construction of critical thinking before any scientific or social phenomenon they face. Dynamic learning, which combines theory and practice, is a tool that can help students to be attracted to science, develop skills in the academic field, be self-taught and competent in their social life, thus promoting a comprehensive approach to education, where one of the ways to evaluate the efficiency of education will be through extracurricular activities based on the use of the implemented platform, thus validating its value as an effective and holistic educational approach, [3].

In teaching chemistry, one of the great challenges is understanding mathematical concepts and solutions that are often used. One of the challenges for the teacher is that the student can relate theoretical concepts with empirical applications of the environment, which will allow the student to assimilate more meaningfully the concepts dictated.

This understanding can be achieved through three interrelated levels of thinking: the macroscopic level, accessible through the senses and allowing us to approach the real world. The submicroscopic level, more imaginative and accessible only through thought, allows us to formulate theoretical explanations of phenomena. The symbolic level, which allows us to express and represent phenomena in written form, both at the macroscopic and submicroscopic level [1].

Chemistry is an experimental science that is usually seen as a matter of memory; however, many concepts can be related to simple practical experiences. Connections can be made between practice and theory through linguistic tools, chemical equations and mathematical calculations integrated into a virtual platform.

1.1 Context of Education with Respect to ICTs

At present, a series of virtual platforms have been created that offer opportunities for free, personalized learning with permanent access to teaching materials. All these advantages have allowed teachers to use these tools and integrate them into the education system so that there is a more didactic approach to learning and not as an isolated support [4]. Teachers face constant challenges to adapt to new teaching-learning processes, some of these challenges involve the reorganization of curricula and pedagogical resources to meet the needs of students. Currently, a new challenge has arisen to incorporate migrant populations, indigenous communities, and people with limited resources into the public education system.

It is important to emphasize that in Ecuador, despite the fact that the national curriculum emphasizes the use of Information and Communication Technologies (ICTs) [5] to facilitate the teaching-learning process, a large part of the population has little or no access to technological tools due to socioeconomic factors or the lack of implementation of these tools by educational institutions that is a consequence of the little teacher training in the field of innovative methodologies. These limitations prevent access and use of both current information and available tools by teachers and students. However, the implementation of new methodologies such as the incorporation of virtual platforms generate significant learning [6]. Anyone can make progressive use of technology to learn about any subject, including science and thus progressively and personally improve their learning.

The methodologies in the teaching-learning processes undergo a constant evolution, there is a growing interest in using education approaches applying virtual platforms with the aim of improving learning processes, expanding educational coverage, and providing flexible alternatives of high quality [6]. The teaching model based on ICTs is an approach characterized by being interactive, adaptable, and collaborative. The model centers learning on the student, allows personalized teaching, without limits of place or time, exploration and exchange of knowledge and multisensory experiences that finally allow a more meaningful learning. “This teaching approach is based on a constructivist pedagogical model that focuses on the student, with the aim of fostering autonomy and knowledge acquisition through collaboration and information sharing” [7].

In our work, various theoretical analyses aimed at evaluating virtual interaction to promote social learning are presented. In addition, based on the aforementioned and with the purpose of solving the needs detected in the teaching-learning process of chemistry, the use of a technological tool is proposed. Specifically, in chemistry the subject of “Electronic Configuration” implies that students have knowledge in relation to the periodic table, chemical symbols, distribution and organization of the elements. Unfortunately, they have been unacquired skills and concepts that prevent them from advancing in the curricular unit. Based on the above, we look for methodologies and resources that allow us to develop skills not only in the field of chemical sciences, but also tools that allow us to take advantage of both intrinsic and extrinsic motivation and the development of critical and analytical thinking by students. The use of the “Educa plus” platform is proposed as a strategy for learning and the implementation of a guide for its management.

The central idea is that interaction becomes the tool for acquiring knowledge. In order to face technological challenges during the educational process and to meet the specific pedagogical needs that teachers may have, through the text particularities and appreciations of the cited authors will be explained. In addition, the interactive processes generated on the platform also enable social learning, the construction of knowledge and the generation of dialogue environments.

2 Methodology

The research is developed with a mixed approach in two sequences: the first of qualitative type where the observation data, interview with teacher and bibliographic review are implemented. The second sequence is a quantitative design where tests were used to assess students' knowledge. The bibliographic review allows to identify the indicators of educational quality with the implementation of the virtual platform "Educa pus".

The bibliographic analysis will allow us to define the main components in the teaching-learning process that are: observation, analysis of participation and knowledge of students. It is important that, in addition to the use of platforms, the teacher has a good planning of the subject, a clear and specific methodology and strengthens the interaction and communication with their students. For the statistical analysis, different factors were taken into account that allowed us to select an appropriate procedure. Each process has different variables that are described in Table 1.

Table 1. Research variables

Variable	Dimension	Indicators	Measuring techniques and instruments
Dependent: Teaching-learning chemistry	Student Learning and Academic Performance	Knowledge acquired	Pre – test Interviews with the teacher and students
		Activity in class interaction	Open-ended chemistry questions about chemical concepts
		Mastery of electronic configuration concepts	Post – test Interview with the teacher and students
	Possibilities for students to access technology and the internet	Accessibility to digital resources	Student interviews
	Use of "Educa Plus" virtual platforms	Knowledge and skills of students and teachers on virtual platforms	Use of virtual platform strategies
			Resource, means, tasks, evaluation, activities
Independent: Teaching through the implementation of virtual platform	Class environment and time arrangement	Distribution of schedules and didactics	Virtual Platform Deployment Methods
	Support and resources for parents and teachers for the proper use of ICTs	Support for teaching-learning with technological methodologies	Activities with the implementation of virtual platforms

This study focuses on a broad range of dimensions and utilizes diverse indicators to deeply comprehend how the implementation of virtual platforms impacts the chemistry teaching and learning process. The dependent variables center around academic performance and student learning, whereas the independent variables encompass the implementation and support of teaching through virtual platforms, considering both technical and pedagogical aspects.

The population for this research were the students of the Millennium Educational Unit YACHAY. I worked with 34 first-year high school students who come from a virtual education in times of pandemic.

For the quantitative evaluation of the students, a pre-test of 10 questions was used before implementing the virtual platform "Educa Plus" and a post-test after the didactic strategy. The answers were measured with Likert scale: nothing, little, regular, enough, and much. The students were also analyzed through classroom observations and group activities that allowed us to have an overview of the students' abilities and their progress in learning based on the knowledge acquired.

On the other hand, the interview will be very useful to gather information from the teacher in relation to her criteria and predisposition to the use of virtual platforms for the teaching-learning process, as well as the reinforcement of the contents in chemistry.

3 Results and Discussion

Based on the data obtained, a large part of the students experienced a considerable improvement in their learning process. They went from getting grades that tended to be low (blue) to achieving much higher grades (red), as shown in Fig. 1.

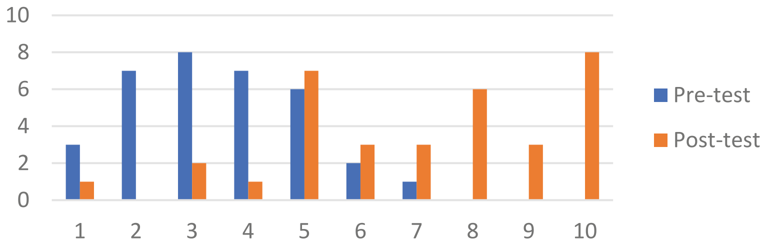

Fig. 1. Comparison between the results obtained in the pre-test and in the post-test (Gades).

The notable increase in student grades reflects the effectiveness of the method implemented in the learning process of students. To obtain a more detailed analysis and accurate visualization of the results, it is recommended to see Fig. 2, where the data are presented graphically, and the improvements achieved stand out. This illustration shows the change generated for each student in the case study. The results show an inferior performance, in spite of having implemented the indicated tool. This phenomenon can be attributed to several factors. Among these, we can highlight the possible demotivation of the students, perhaps influenced by lower previous grades. Likewise, the level of interest that students give to the subject and the amount of time they dedicated to their own learning can also be considered as an influential factor in this situation.

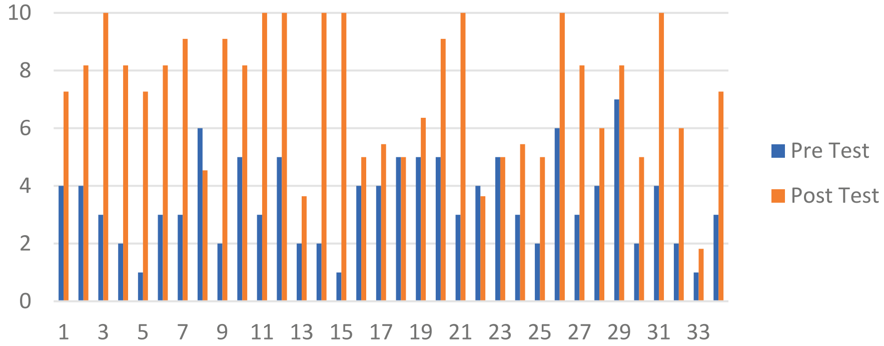

Fig. 2. Results obtained in the pre-test and in the post-test, for each of the students.

3.1 Interpretation of the Interview

The teacher's answers during the interview showed, on the one hand, the lack of interest of the students in learning, as well as the lack of availability of resources or tools that can be used to improve the teaching-learning process in the classroom.

1. **What strategies implemented in chemistry teaching were or were not effective during the pandemic?**

Strategies such as project-based learning, home experiments and the phet virtual platform were implemented. However, they were not entirely effective as the students showed no interest.

The lack of interest in the virtual platform used may be due to its high complexity, which is not very attractive to students.

2. **Do you consider that the use of virtual platforms is effective for the learning of chemistry by students?**

Yes, it would be useful, although some students do not have access to the internet and it is complicated to use it for their learning. However, I believe that if it is implemented in a coordinated manner during class hours, new knowledge could be generated.

According to the teacher's comments, a greater approach of students to ICTs would be useful, however, this has complications, due to the students' own interest and the economic lack to acquire technological devices or hire internet.

3.2 Impediments to Results

At the time of carrying out this study, specifically in the analysis of results we can visualize some impediments that limit the research and are:

3.2.1 Sample Selection

We could highlight the study carried out by Asencio and Ibarra (2022) where they highlight the importance of adequately evidencing the sample that will be used in an investigation. It is important to note that the sample can be considered as a subset of the entire study population, where the acceptance or rejection of the research depends on the quality of the selected sample. In this way, it is essential to make a clear sample selection that guarantees the confidence and validity of the study.

In our research, the sample selected was a specific group of students proposed for the case study, it should be considered that there were two courses of students in which we worked with only one of the groups as we indicated. We also believe that this selection may affect and limit the overall results to a broader scale. Within the analysis, a random or representative selection of the population had to be followed, as this may generate biases and particularities in the results. Therefore, this limitation must be taken into account when interpreting the results of the research.

3.2.2 Longitudinal Effects

The second aspect to consider is longitudinal effects, which refer to the time needed to plan a problem and the changes that can be generated in each period, according to Avello et al. (2019). Doing a study in a specific time can generate limitations to the case study, since there may be long-term variations, and this can affect the validity of the results. In our study it is important to mention that there was a specific period for conducting the research.

3.3 Discussion

In the rapidly evolving landscape of education, the role of teachers has been undergoing transformative shifts with the integration of innovative methodologies, particularly in the context of teaching and learning chemistry. This paradigm shift has catalyzed a reevaluation of pedagogical praxis and teacher training methodologies, ultimately leading to more effective educational outcomes. Embracing new teaching approaches that draw on philosophical theorems of chemistry offers educators an enriched foundation for crafting engaging and enlightening learning experiences [3]. Through well-structured teacher training, educators can empower themselves with the necessary skills to harness the potential of virtual platforms, creating interactive and collaborative classroom environments that foster active learning.

The introduction of digital tools has ignited renewed motivation and interest in the realm of chemistry among students. These tools have proven to be instrumental in cultivating essential cognitive and technological skills. By employing virtual platforms and interactive resources, educators can tap into the digital prowess of today's generation, leveraging multimedia elements, simulations, and dynamic content to elucidate complex chemical concepts [7]. This approach not only enhances understanding but also kindles curiosity and enthusiasm for the subject matter. Moreover, the integration of these tools into the learning process nurtures crucial skills like critical thinking, problem-solving, and digital literacy, which are indispensable for success in both academic and professional endeavors.

Technology's pivotal role in education is evident as it reshapes learning with engagement, collaboration, and personalization. Moving from one-way teaching to interactive platforms marks a monumental shift towards student-centered learning. Quantitative results highlight tech's positive impact on academics and student motivation. Table 2's evidence of virtual platforms in chemistry education further strengthens this method's foundation: interactive learning and educational excellence through virtual tools.

To enhance the efficacy of such methodologies, it is imperative to meticulously establish the fundamental characteristics of the chosen virtual platform. This approach prioritizes interactivity, user-friendliness, and compatibility, ensuring that technological complexities do not impede the learning experience. Moreover, identifying the pivotal components that contribute to the quality and enrichment of teaching and learning is paramount. An interactive platform must not only facilitate engagement but also encapsulate a high standard of virtual learning environment, supporting multifaceted activities that cater to diverse learning styles and preferences. Scholarly reinforcement and empirical research serve as cornerstones for substantiating the significance of virtual environments in knowledge acquisition and construction. By advancing an evidence-based approach, educators are better equipped to guide their pedagogical choices, resulting in effective and meaningful learning experiences that extend beyond the confines of the classroom.

In the triumvirate of knowledge, teacher, and student, the role of the teacher becomes increasingly pivotal. As educators embrace digital tools and virtual platforms, they become facilitators of knowledge exploration, guiding students through the intricate tapestry of chemical concepts. This transition necessitates a shift from traditional didactic instruction to a more dynamic and participatory model. Teachers morph into curators of learning experiences, orchestrating collaborative projects, interactive discussions, and problem-solving exercises that transcend the boundaries of textbooks. This transformation redefines the teacher-student dynamic, fostering an environment of co-creation and shared exploration, where the teacher's expertise interweaves with students' inquisitiveness and technological adeptness.

Table 2. Authors who contribute to interactive learning and virtual platforms.

Authors	Contribution in the line of research
[1]	Reflections on the role of teacher with new methodologies improving pedagogical praxis in the teaching and learning of chemistry
[3]	Teacher training based on philosophical theorems of chemistry
[7]	Educational strategies for active learning in the area of chemistry interrelating the trilogy of knowledge, teacher and student
[8]	The knowledge of teachers to implement virtual platforms generating an interactive and group class
[9]	Digital tools generating motivation and interest in chemistry by developing cognitive skills and technological skills

In summary, the amalgamation of technology with pedagogical innovation presents a compelling narrative of transformation in education. This evolution goes beyond the mere transmission of knowledge, encompassing the holistic development of students' cognitive faculties, digital skills, and motivation to learn. Through the strategic utilization of virtual platforms, educators are poised to cultivate a generation of learners who are not just proficient in chemistry but are also equipped with critical skills for success in an increasingly technology-driven world. This transition is underpinned by comprehensive teacher training, the application of philosophical theorems, and the strategic interplay between digital tools and active learning strategies. As educational frontiers continue to expand, the trilogy of knowledge, teacher, and student remains a guiding constellation, charting a course towards pedagogical excellence in the domain of chemistry and beyond.

4 Process of Implementing "Educa plus"

At the global level, the establishment of standards that allow certifying the quality of projects based on interactive learning tools is sought. The incorporation of technology in education implies reconsidering teaching methods and training in virtual environments should be seen as useful tools that can be accessed to improve the acquisition of knowledge. The interaction of students and teachers with technology leads to the formation of virtual communities that are finally also communication channels.

This proposal involves the participation of teachers and students in order to facilitate their learning and mastery of the online platform. On the platform, information will be provided on symbols, names of compounds and their electronic configuration according to their atomic number. The students' previous knowledge, combined with the new knowledge acquired, will contribute to the creation of a meaningful learning process. The proposal aims to serve as a manual of activities that allows improving the teaching-learning process of students, using technology as an interactive tool and encouraging teamwork. All this will contribute to achieving meaningful learning by combining theory with practice on the virtual platform "Educa Plus". The objective of introducing this platform as an educational resource is to stimulate students' interest in chemistry and facilitate dynamic learning, while promoting the integration of technology in education by the educational community.

4.1 Components that Guide the Development of Activities

The main objective of the proposed teaching strategy is to facilitate the understanding of the structure of an atom and the electronic configuration, encouraging the connection between theoretical concepts and reality. This allows students to strengthen the acquired knowledge and encourage interactivity in the learning process. Since Experimental Sciences are based on facts, laws and principles, especially in the context of transmitting more complex knowledge, the following essential components have been identified for this educational approach:

- Interactive learning: the generation of creative and innovative structures that allow the flow of connections between ideas is promoted. This facilitates stable and meaningful learning, where students can relate and apply concepts in a practical and dynamic way. The interactive approach encourages active student participation, exchange of ideas and peer collaboration.

- Motivation and active learning: The importance of keeping students motivated and engaged in the learning process is recognized. Rather than being limited to theory and passive observation, students are given the opportunity to "learn by doing". This implies that students can manipulate and experiment with the concepts, which in turn contributes to the development of stronger mental skills and procedures.

With these components in mind, the following proposal is put forward for practical application in the classroom:

- Design interactive activities: activities should be designed that promote interaction and dialogue among students. This may include debates, group discussions, presentations, hands-on demonstrations, simulations, experiments and collaborative projects. These activities will allow students to connect theoretical concepts with real-life situations, thus strengthening their understanding and application of the subject matter.
- Provide adequate resources and tools: It is essential to have resources and tools that support interactive learning. This may include visual materials, simulation software, physical models, laboratory equipment, internet access and other relevant resources. By using these resources effectively, students will be able to explore and experiment with the concepts, which will increase their active participation in the learning process.
- Stimulate curiosity and creativity: Curiosity and creativity should be fostered in students, encouraging them to ask questions, seek answers for themselves and propose innovative solutions. This can be achieved through open-ended challenges and problems, research activities, individual or group projects, and exploration of practical applications of the concepts learned.
- Provide timely feedback: It is important to provide constant and constructive feedback to students. This allows them to assess their progress, identify areas for improvement, and strengthen their understanding of concepts. Feedback can be provided by both the teacher and peers, through reviewing assignments, evaluating projects, or participating in group discussions.

By implementing these components and considering these guidelines, an active, participatory, and meaningful learning environment will be promoted for students, allowing them to acquire a deeper and more enduring understanding of atom structure and electronic configuration.

4.2 Criteria According to the Education Curriculum

Proficiency with Performance Criteria:
"CN. Q.5.1.5. Observe and apply the quantum-mechanical model of matter in writing the electron configuration of atoms considering electron duality, quantum numbers, types of orbitals and Hund's rule" [10].

Evaluation Criteria:
"CE. CN. Q.5.2. Analyzes the structure of the atom based on the comparison of the atomic theories of Bohr (explains the spectra of the chemical elements), Democritus, Dalton, Thompson and Rutherford and performs exercises of the electronic configuration from

the quantum-mechanical model of matter" [10]. The evaluation indicators, techniques and instruments to interactive learning and virtual platforms could see in Table 3.

Table 3. Evaluation indicators, techniques and instruments to interactive learning.

Parameter	Contribution of virtual platforms
Evaluation indicators	I.CN. Q.5.2.1 Analyzes the structure of the atom by comparing the atomic theories of Bohr (explains the spectra of the chemical elements), Democritus, Dalton, Thompson and Rutherford, and performs exercises of the electronic configuration from the quantum-mechanical model of matter. (I.2) [10]
Techniques and instruments	**Resources** Computer or cellular phone and internet Educa Plus virtual platform **Techniques** Observation of the criteria and knowledge of the students on topics related to Electronic Configuration Interaction of constructivist learning **Instruments:** Questions about "electronic configuration" Evaluation on "electronic configuration"

Learning Objectives

- Value the contributions of chemistry based on critical and reflective reasoning creating responsibility and using technological means providing the theoretical with the practical.
- Demonstrate critical scientific skills that allow the investigation and curiosity of atomic models and chemical elements by applying those learned on the subject of "Electronic Configuration" through the Educa Plus platform.
- Allow students to learn and understand "Electronic Configuration".

4.3 Learning Activities and Use of the Virtual Platform

Anticipation

- Research how to use the Educa Plus platform.
- General indications on the use of Educa Plus "Electronic configuration".

General Indications of the Platform

- Enter the electronic configuration of the virtual platform for interactive resources "Educaplus" (Fig. 3).

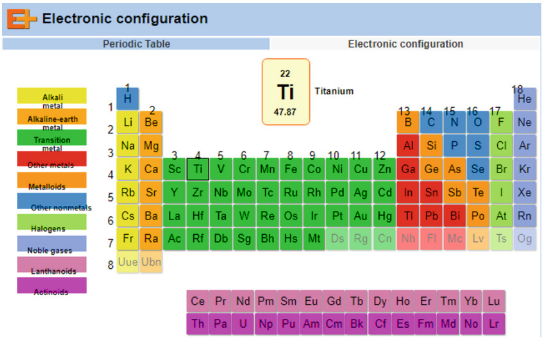

Fig. 3. Educa plus virtual platform startup

- Select element to develop the electronic configuration, once selected click on "electronic configuration" (Fig. 4).

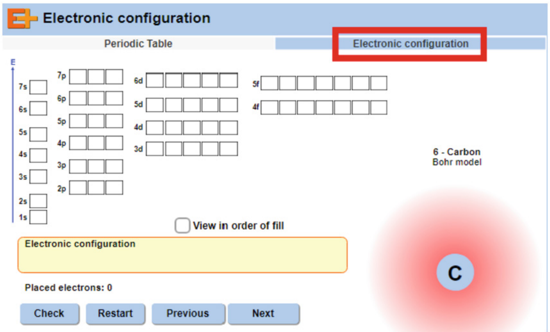

Fig. 4. Electronic configuration, Bohr model

- Being on this page you can see the symbol of the element, the electronic cloud and the levels in a precise order.
- As the order electron spin stipulated according to the theory is placed, electrons will appear in the cloud (Fig. 5).

- Through this interactive platform you can consolidate theory with practice where you can learn by playing with the elements, and identifying their symbols, also allows

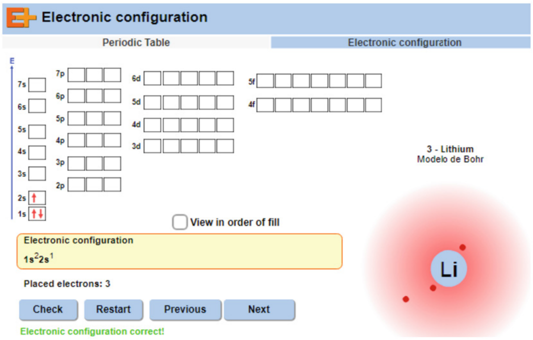

Fig. 5. Checking the electronic configuration of the element

you to observe the number of electrons in the electron cloud density, which allows students to consolidate their teaching and learning.

4.4 General Recommendations Before the Implementation of the Proposal

- Socialize aspects and criteria of the class: It is essential to establish clear and open communication with students about the aspects and criteria that will govern the dynamics of the class. This includes the presentation of the learning objectives, the contents to be covered and the performance expectations. By socializing this information, students will have a clear understanding of what is expected of them and will be able to engage more effectively in the educational process.
- Establish agreements and commitments between students and teachers: To foster a harmonious environment conducive to learning, it is important to establish agreements and commitments on the part of both students and teacher. These agreements may include aspects such as mutual respect, punctuality, active participation in class, and responsibility for assigned tasks. By establishing these guidelines from the beginning, an atmosphere of trust and collaboration is created that favors the teaching-learning process.
- Explain the evaluation: It is essential to provide a clear and detailed explanation of the evaluation criteria to be used in the class so that students can plan and organize their study time effectively.

By following these general recommendations, a solid foundation is established for the implementation of the proposal, promoting a favorable learning environment and facilitating the active participation and commitment of students.

5 Conclusion

In the results of the research on the use of virtual platforms in the interactive teaching of chemistry, coincidences are identified that support the need to adopt an education that takes advantage of technological resources to create motivating, dynamic and communicative environments. According to the analysis of the theoretical foundation, it is highlighted that platforms are an effective resource in education; therefore, it is important to improve the skills of both teachers and students in the management of digital tools and understand their relevance to effectively implement interactive learning, thus enhancing knowledge and generating satisfaction in the process. The proposal is directed to what was identified in the study, to the dependent variable: teaching learning of chemistry and independent: teaching through the implementation of virtual platform, this allows a practical application allowing to increase the confidence of students in their preparation with the virtual platform.

As mentioned previously, the analysis of results supports the idea that the implementation of didactic strategies favors the teaching-learning process. The study revealed a high acceptance by students, who confirmed its effectiveness. In addition, it would be advisable to replicate the study in a larger sample to corroborate the data obtained in this particular case. Finally, it is important to keep in mind that not all strategies have the same acceptance, since each student has a unique learning style.

It is necessary to recognize and adapt education to the digital environment, taking advantage of the tools available to build individuals prepared for the global era. This implies encouraging dialogue and interactive learning, breaking with traditional schemes and overcoming cultural barriers. Evidence shows that technology is effective and necessary in the educational field. On the contrary, if the new challenges are not accepted, the new generations could be affected, experiencing apathy and demotivation. In order to achieve this objective, this article offers criteria to characterize teaching-learning, ensuring that its implementation is adequate and that the results are evaluated effectively. This allows a quality training alternative that encourages student competence. Therefore, it is imperative to increase efforts to promote the application of virtual platforms in the field of education, as this improves the quality of the learning process.

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Chapter 10

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