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Influence of didactic strategies in the learning of biochemistry in students of a university in the Mexican Southeast

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Abstract

The purpose of this study was to evaluate the relationship between the teaching strategies used by teachers in teaching biochemistry and the level of learning achieved by students. The teaching-learning process in higher education institutions must adapt to the current demands and requirements of a constantly changing society. University students who study biochemistry need to develop skills that encourage self-learning. The research was carried out with 115 students from a university in the southeast of Mexico, (USoM), to observe and describe a phenomenon. Since there was no control or manipulation of variables, we classify this study as descriptive and "ex post facto," given that the phenomenon had already occurred. Students primarily developed their competencies in comprehension (37%) and analysis (33%). However, when applying for a pilot exam, the majority of responses focused on the aspects of knowledge (36%) and understanding (32%). The present study was carried out under the ethical conditions of informed consent of the participants, promulgated in the Declaration of Helsinki. The participation was voluntary, it was developed with an attitude of empathy, and respect, emotional support, and understanding. The confidentiality and privacy of participants were protected at all times. According to the results observed, a transformation in the didactic strategies employed in the teaching of Biochemistry in the Health Science courses in Mexican universities is suggested.

Keywords: Biochemistry, Didactic strategies, Self-learning, Society, Teaching strategies, University students.

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1. Introduction

Higher education in Mexico in the 21st century is undergoing profound changes to adjust to current demands on the economic, social, political, and cultural levels. Enrollment increases exponentially, along with coverage, to offer a wide educational offering that adjusts to the needs of each context. Observing what transpires in classrooms today is a central theme is education, as these spaces shape the future of students [1].

Upon entering the university, students have great heterogeneity, they begin their teaching-learning process with great expectations for their future lives. During their academic journey in the classroom, you can observe talented, outstanding, good or bad students or students with limitations [2]. To meet current demands, university students need to develop skills, such as carrying out collaborative work, applying advanced knowledge, professional and disciplinary techniques, and transversal skills that help them adapt to current demands [3]. Learning for university students focuses on learning to learn and conditioning their behavior based on experiences [4]. And teaching how to learn is required for the development of their professional skills [5]. However, our environment necessitates new practices, resources, activities, and social interaction, which must include technology to transform young people into new educational approaches [6].

Acevedo and others, cited by Visbal-Cadavid, et al. [7] stated that "students are all different, they have varied personality types, and the learning strategies to be used are, in turn, diverse, and they learn with different modalities." Díaz and Hernández [8] mention that the learning strategies that the student uses for meaningful learning of information are usually flexible [8]. Teaching strategies are those that the teacher uses to achieve set objectives and transform their environment through collaborative work [9, 10].

The teaching and learning process allows the student to develop a methodology that generates a way of thinking, feeling, and carrying out. This process, which is influenced by the university climate, collaborative work, behaviors of teachers and classmates, perceptions, relationships, and objectives, allows its performance at the university level and outside of it Rocha [11]. It must be considered that to generate this teaching and learning, it is essential to have a good school climate that involves cohesion, communication, cooperation, autonomy, organization, and the teaching management style [12].

Four groups of strategies are considered: cognitive, teaching, didactics, and learning [13]. Among the strategies are: case studies, brainstorming, role-playing, research work, repetition and practice activities, exposition, and development of conceptual maps, which allow learning styles such as active, pragmatic, theoretical, and reflective [13]. Connection exercises between concepts, terms, reactions, and biological meanings [14, 15].

Furthermore, “learning is a process that allows knowledge, continuous cognitive processes with successive elaboration of structures, and creation of links between the mental, neurological, socio-affective, and sensory-motor aspects” [16]. The teacher must instill in university students the ability to learn and engage in self-reflection [17].

The learning of biochemistry in students of health careers, in public universities, requires that, for the comprehension and understanding of chemistry in all the vital processes of life, that is, the molecular composition, the metabolic cycles, integration, and disintegration, which make up molecular life, for its maintenance and allow the proper functioning of the organism at the cellular level [13].

Due to the complexity of the processes studied in biochemistry, students in the health area present many difficulties in the teaching-learning process, especially due to how they are taught, among other factors that affect the difficulties in their learning [18]. The teaching-learning process of universities must be governed by strict scientific rigor.

The results of the research offer the opportunity to develop recommendations to reflect on and improve teaching practice in the teaching-learning process of biochemistry. In addition to providing high-quality education to students, and teaching them through didactic strategies that adjust to current needs, this also helps in the formation of their competence in their professional training in the area of health.

According to the above, the objective of this research was to evaluate the relationship that exists between the didactic strategies used by teachers in the teaching process of biochemistry and the level of school learning achieved in students at the undergraduate level in the health sciences degrees at a university in the southeast of Mexico.

2. Methodology

2.1. Type of Research

This research is mixed-methods, using qualitative research methods with in-depth surveys of teachers, student surveys, and exams, for data collection. We used quantitative research methods, employing a questionnaire to validate the data using statistical values. We also selected and applied the three instruments to pilot group of 35 students and 2 teachers for validation.

2.2. Sample

This study analyzes the specific characteristics of the population, made up of 115 2nd year students. Semester of Health Sciences careers, a university in the southeast of Mexico, (USoM) was carried out in the school period from February to June 2022.

What was intended was to observe and describe a phenomenon, no control or manipulation of the variables was carried out, which is why this study was descriptive and "ex post facto" because the phenomenon had already occurred. According to the chosen methodological criterion, the existing relationships between two variables were discovered: teaching strategies and learning. The technique used to analyze the data was Pearson's correlation.

2.3. Methodology

This study's methodology involved two phases: the first phase involved collecting information through questionnaires and objective tests, while the second phase involved calculating the correlation between the observed variables. The study population was made up of 115 students, and a representative sample equal to 91 was selected, applying the formula N= n'/ 1 + n / N', using a confidence level of 1.64 (90%), which was formed in two aspects: The pilot sample was structured with 35 students and three teachers, and the total study sample was made up of 91 students and three teachers. The calculation of the proportional distribution of the sample was carried out by applying the formula: Nh / N, and a the sample was selected through stratified random probabilistic sampling. In the case of teachers, the population size was equal to the sample.

2.4. Instruments, Procedures y Data Analysis

The instruments used are based on a survey of the teaching strategies used by the teacher in their educational work. This survey was applied to the pilot group of teachers (2) and the sample group of teachers (3); The results of this survey determined the level of appreciation that each teacher has for their teaching practice. Each aspect related to their educational work was assigned a point, except sections c and d, which, according to the "Likert" scale, ranged from "very frequently" with 4 points, "frequently" with 3, "rarely" with two and "never" with one point. We used a second instrument, a questionnaire to gauge the characteristics of each teacher's teaching strategies, based on the opinions of the group of pilot students and the sample.

We have prepared 31 questions for instrument, covering the following aspects: Five questions refer to the planning of their classes, four questions determine whether it promotes the teacher-student relationship; two refer to whether it promotes cooperation between students; 13 refer to the use of active learning, and 7 that determine the effectiveness of the evaluations. The responses were Likert-type, ranging from "very frequent" with 4 points, "frequently" with 3 points; "rarely" with 2 points, and "never" with 1 point. Each student has a total score of 124 points. The third instrument is an exam that is measured with an objective evaluation. The type of learning that the students have was structured with 43 items divided as follows: The first ten items evaluated the level of knowledge; The next ten determined the level of understanding; The analysis was measured in the following fourteen items, the following six were knowledge items, and the last three measured the level of application, according to Bloom's taxonomy. Each correct answer was assigned a score equal to 1, those not answered and answered incorrectly were assigned a score of zero. Each student can score a maximum of 43 points.

3. Results

We calculated the distribution of the total sample (91) using the formula:Nh / N, where Nh represents the subpopulation or group and N represents the population. This resulted in the following group distribution: 25 students in Group 1 (27.47%), 2nd. semester "A", where the teacher who teaches the subject was assigned No.1; Group 2 was made up of 31 students (34.06%), 2nd. Semester "B", whose teacher was assigned No.2; and, finally, the third group studied was formed by 35 students (38.46%), whose subject title was assigned No.3, 2nd. Semester "C", as can be seen in the following Table 1.

Table 1.
Classification by groups.

Teacher	Groups studied	Total students per group	Total students served per group
1	2do. A[1]	29	25
2	2do.B[2]	39	31
3	2do.C[3]	47	35

Note: Table 1 values 1,2,3 refer to the group of students in the second semester (2nd) of the health science programs, studied and divided into 3 groups; A, B, and C.

We conducted a pilot study with 35 students and 2 teachers, who were not part of the original sample and whose selection was completely random, to determine the validity and reliability of the instruments used in this research. Concerning instrument 3, the "split halves" procedure was used, resulting in 0.6, which indicates that there is a moderately high relationship between the different items of the objective evaluation applied to the students.

Instrument 2 yielded a reliability of 0.73 using the same "broken halves" formula, indicating a moderately high and consistent relationship between the questions posed to the students and their responses.

Concerning the same instrument, analyzing it in more detail and applying the "broken halves" formula to these data, value of 0.76 is obtained, which again indicates that the concepts that are related in the exam have a moderately high positive correlation.

Each concept establishes a connection with the others. Furthermore, it can be determined that, depending on the type of learning developed by the students, the score with the highest percentage is located in the aspect of understanding (37%).

Table 2 displays the analysis at 33%. However, in the application of the pilot exam, the majority of the answers given by the students focused on the knowledge aspect (36%), and on comprehension (32%), as can be seen in Table 2.

Table 2.
Percentages of Bloom's taxonomy categories contained in the objective and pilot examination.

Bloom categories	Objective exam (%)	Pilot exam (%)
Knowledge	23%	36%
Comprehension	37%	32%
Analysis	33%	22%
Application	7%	10%

If we compare both percentages, it can be seen that the students' response was below what was expected, since of a total of 1,505 that they could have achieved overall, they only obtained 800 points, giving rise to a similar phenomenon in each of the aspects that included the objective examination (see Figure 1).

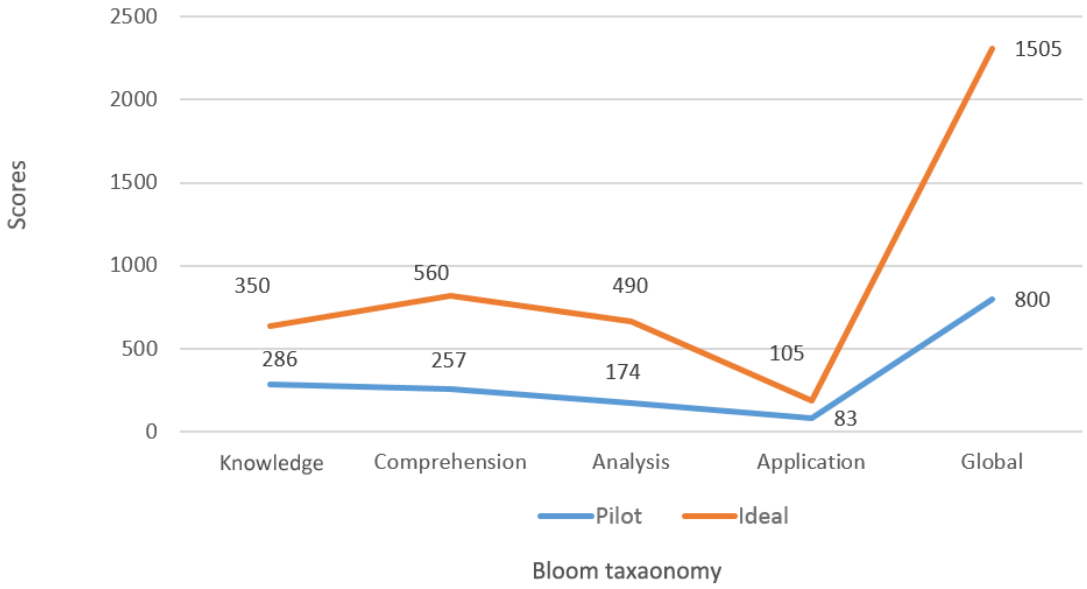

Figure 1.
Comparison between actual and ideal pilot exam scores.

About the evaluation of teaching performance by the pilot group, it can be seen that the highest score fell on active learning, obtaining 1,599 points, which represents 42.6% of the total, giving cooperation the lowest score (251), which represents 6.7%, which indicates that in the pilot group, the teachers are seen as barely promoting cooperation among students, although most of their activities are focused on active learning (see Table 3).

Table 3.
Teacher evaluation (Pilot).

Assessment	Punctuation	%
Planning	583	15.53
M-A relationship	509	13.56
Cooperation	251	6.70
Active learning	1599	42.61
Assessment	810	21.60
Total	3752	100

Regarding the results of the objective evaluation applied to the students of each teacher, it can be observed that in the aspect of knowledge, teachers 1 and 2 have similar scores (158 and 155 respectively), with which it can be inferred that these teachers promote rote learning; regarding the aspect of understanding, the students of teachers 2 and 3 reach similar scores (128 and 130, respectively), that is, they promote this area, although teacher No. 1 is not very far from them (110); regarding the ability to analyze, the students of teacher No. 1 are the ones who had the highest score (94); regarding the area of application, the students of teacher No.2 are the ones who obtained the highest score (59) (see Figure 2).

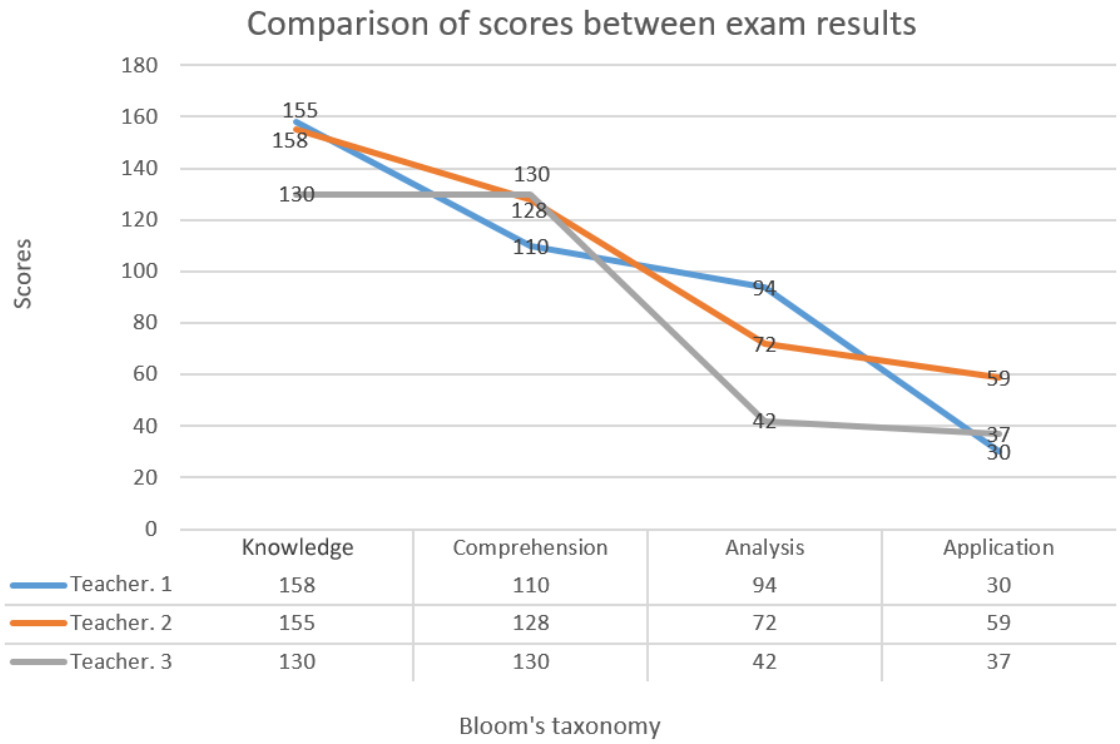

Figure 2.
Comparison between the results of the objective evaluation applied to the students of each teacher.

Regarding the evaluation applied to teachers, it can be seen that the expected ideal score, which represents excellent teaching performance, was not achieved by any of the three teachers studied. The results of the surveys of each of their groups indicate that teacher No.2 was the one with the highest percentage score (76%), which however represents a moderately acceptable rating in terms of his performance, followed by teacher No.3 with a score of 71.06%, which means a medium level of acceptance, and finally teacher No.1 barely achieved a percentage score of 60.06%, with a barely acceptable teaching performance. These data can be seen in Figure 3, which only shows the total scores in a comparison of the ideal total and the real one. The above agrees with the assessment made in instrument 1.

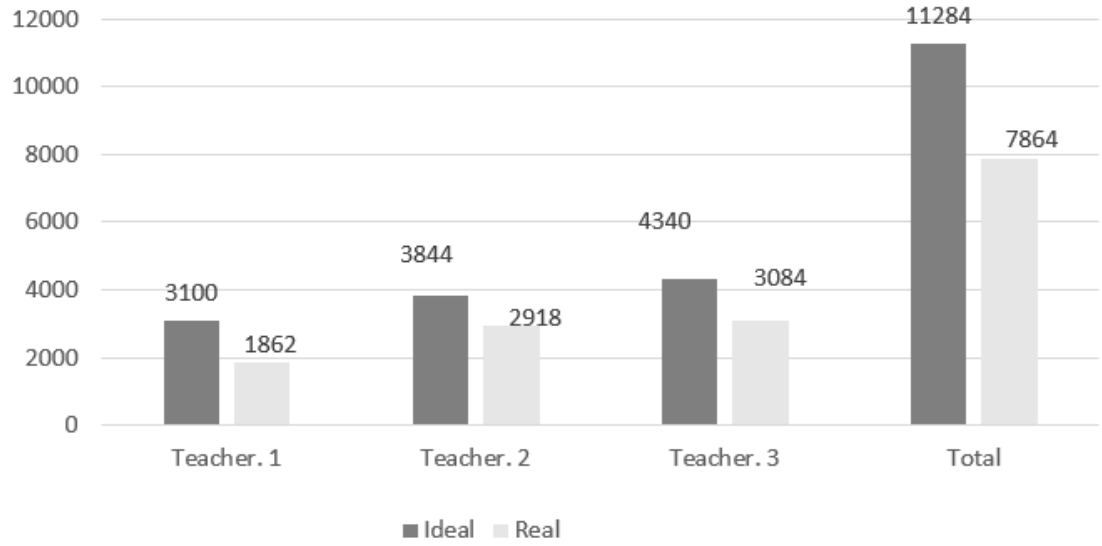

Figure 3.
Comparison of teacher evaluation scores.

The result of the present study allows us to observe that students in biochemistry courses use a type of learning based on understanding, analysis, and knowledge, as mentioned by Petric and Sucari [5]. They are acquired with specific qualities of structure and time organization that may or may not be mediated by motivation, responsibility, verbal ability, and optimism. This learning process involves studying as a means of acquiring knowledge and achieving success [5].

The teaching practice that is promoted is traditional, with the subject taught with explanations of specific concepts, which prevents its students from developing their analytical-reflective capacity. The subject of biochemistry requires that the teacher generate an active role for self-learning, working on case studies allows learning concepts, and practical

training15. It is the teacher who is an agent of change who must enrich knowledge, organize learning, guide in the analysis of real situations in the context, enable the construction of knowledge, establish strategies to use, facilitate reflection, and generate creativity to solve problems. The teacher is responsible for daily assessments and evaluations of various processes. It is a facilitator and mediator, seeking to incorporate more pedagogical elements that privilege skills of discernment, argumentation, critical thinking, and creation of causal, semantic, and analogical relationships [19].

For teaching performance, it was found that this is acceptable since it plans its classes, and promotes active learning with a higher score and collaborative work with a lower score. To exercise their profession, teachers must consider didactic aspects, knowledge of the science they teach, class organization, student learning styles, and task planning, among other aspects [20].

4. Conclusions and Discussion

The teacher with the best performance obtained 76%, in the vision that his students have regarding the teaching strategies he uses, and of the 36.15% of the academic achievement of his students, it cannot be said that he has an excellent pedagogical performance, since it is observed that the teaching methods and strategies used by this teacher are traditional; he encourages rote learning, concrete explanations, leaving aside the innovations that could be applied to obtain optimal learning of his subject. In the study carried out by Mendoza et al on the level of use of teaching-learning strategies by teachers, they use cognitive teaching strategies (cognitive skills) as a medium, so 37% of teachers use the skills cognitively, 44% use them sometimes, and 19% do not use them [21].

It is obtained that the teaching methods and strategies that are most commonly used in school are traditional, which promote the acquisition and rote repetition of concepts, facts, etc. Traditional methods promote the simplest type of learning, that is, they focus on the acquisition of knowledge, and that is, they prepare the student to develop the action of remembering and repeating mechanically. Among the most commonly used teaching methods and strategies are those centered on the teacher, such as dictation and repetitive explanation. Pamplona et al conclude that learning strategies are related to the training and qualification of teachers, and despite knowing various strategies, they continue to generate training processes in traditional education [22].

According to Bloom [23] and Pinillo, et al. [24] deductions, regarding the reasoning process involved in problem-solving, indicate that students are capable of providing more complete information regarding the formulation of a problem when it is more complicated, that is, when it can be classified within the highest classes of technical abilities and intellectual aptitudes. Bloom [23] and Pinillo, et al. [24]. Torres-Zapata, et al. [25] suggest that biochemistry students solve problems systematically, and unconsciously and that they can be perfected to establish the best solution strategies and improve their skills [25].

The teacher's role extends beyond merely imparting knowledge; it involves assisting students in learning. We must integrate teaching and learning into a single process, where both teachers and students build knowledge. In this construction process, the teacher is the one who must guide and guide the student [26].

Teaching strategies play a fundamental role in determining the type of learning achieved by students. The level of knowledge acquisition by students is closely linked to the teaching methods and strategies used by teachers. In the school environment, traditional methods, which emphasize memorization and mechanical repetition of concepts and facts, are widely used. These methods, by focusing primarily on knowledge acquisition, prepare students to remember and repeat routinely. Among the most common teaching strategies are those focused on the teacher, such as dictation and repetitive explanation. These practices significantly influence the type of learning that students experience.

5. Recommendations

A transformation is recommended in the didactic strategies used in teaching biochemistry in health sciences courses in Mexican universities. We suggest implementing innovative approaches like active learning and technology integration to foster meaningful learning. In addition, emphasis is placed on the development of transversal skills in students, promoting collaborative work and adaptability to current demands. We highlight formative assessment and continuous feedback as key tools, along with promoting self-learning and creating a positive school climate. Continuous training of teachers in modern strategies and the exploration of interdisciplinarity are considered essential. Additional research is encouraged to identify specific strategies that optimize the teaching-learning process in the context of Biochemistry, seeking to improve educational quality comprehensively.

6. Limitations

The study has limitations, such as its "ex post facto" descriptive design that prevents establishing causality, and the non-random sample is limited to a single semester and university, limiting generalization. Assessing learning only through an objective exam may not reflect all students' abilities. The lack of diversity among teachers and the absence of relevant control variables affect the representativeness of teaching strategies. The self-assessment of teacher performance based on student perceptions can be subjective, and the lack of practical recommendations limits the applicability of the findings in education.

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