

TEACHING STRATEGY: “KREBS’ HOUSE” — A NARRATIVE- BASED ALTERNATIVE TO FACILITATE UNDERSTANDING OF THE KREBS CYCLE.

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Resumen.

It has been identified that teaching the Krebs cycle at the university level presents certain difficulties. To address this challenge, a narrative-based teaching strategy was designed and implemented with first-semester medical students at Fundación Universitaria San Martín in Sabaneta and with upper-semester undergraduate students in Natural Sciences Education from Universidad de Antioquia.

The results showed that this is a teaching alternative highly valued by students and that it enables them to understand the cycle, achieving average scores close to 80% correct responses on specific knowledge tests. Additionally, the majority of students perceive that they have sufficient knowledge of the cycle to explain it, with a few exceptions that may serve as subjects for future studies.

Keywords: Krebs cycle, narrative, teaching alternative, perception of learning.

Abstract.

Se identificó que la enseñanza del ciclo de Krebs, a nivel universitario, presenta ciertas dificultades. Con el objetivo de enfrentar este desafío, se diseñó una estrategia didáctica basada en la narrativa, que fue implementada con estudiantes de primer semestre de medicina de la Fundación Universitaria San Martín de Sabaneta y estudiantes de licenciatura en ciencias naturales, de semestres superiores de la Universidad de Antioquia. Se recolectó información sobre sus saberes previos sobre el ciclo, y los preconceptos sobre la dificultad del mismo, de igual manera, tras la presentación de la estrategia a los estudiantes, se realizaron dos pruebas, que permiten extraer información en términos de su apreciación de la alternativa didáctica, y de su utilidad para comprender la estructura del ciclo, los resultados mostraron que es una alternativa didáctica muy apreciada por los estudiantes y que permite la comprensión del mismo, logrando resultados en promedio que se acercan al 80% de respuestas acertadas en pruebas de conocimientos específicos. Adicionalmente, los estudiantes en su gran mayoría perciben que tienen suficientes conocimientos acerca del ciclo para explicarlo, con algunas excepciones, que pueden ser caso de estudios posteriores.

Palabras Clave: Ciclo de Krebs, narrativa, alternativa didáctica, percepción sobre el aprendizaje.

ESTRATEGIA DIDÁCTICA: "LA CASA DE KREBS" UNA ALTERNATIVA EN FORMA DE RELATO PARA FACILITAR LA COMPRENSIÓN DEL CICLO DE KREBS.

I. INTRODUCTION.

Since the first diagram of the tricarboxylic acid cycle, also known as the citric acid cycle or Krebs cycle (Krebs et al., 1938), was introduced and generated through a methodology that had previously enabled the same author to elucidate the urea cycle in 1932 (Quesada Molina, 2014)—various authors have contributed to improving the understanding of the organization and structure of the Krebs cycle.

For example, some contributions involved describing the organization of its enzymes within the mitochondria (Robinson & Srere, 1985) and elucidating inhibition mechanisms such as those produced by malonate (Pardee & Potter, 1948). Additionally, the Krebs cycle was incorporated into metabolic pathways beyond glycolysis, such as fatty acid oxidation (Lehninger, 1945).

All these contributions not only improved the understanding of the structure of the Krebs cycle but also highlighted its central importance in mitochondrial and cellular metabolism.

Due to this significance, university programs in health sciences, exact sciences, engineering, and education, which include biochemistry courses must address thoroughly understand this metabolic pathway, covering its substrates, enzymes, coenzymes, energy-producing reactions, inhibitors, anaplerotic pathways, among others.

Despite this, teaching the Krebs cycle remains a significant challenge in university-level biochemistry education. In particular, a study conducted by the Fundación Universitaria del Área Andina in Bogotá in 2009 identified the traditionalist approach to teaching this topic as one of the factors contributing to students' learning difficulties.

In the search for alternative teaching strategies across different fields, it has been found that narrative often organizes the structure of human experience, enable individuals to understand both their own actions and those of others, to structure events and objects coherently, and to connect and analyze the consequences of actions within their temporal context. Narrative is not only a means of representing reality but also of constructing it (Bruner, 1991).

Narrative should therefore be valued as a vehicle through which the world can be understood in new ways and through which new ideas can be communicated. At a cognitive level, narratives are often employed as schemas, scaffolds, or templates to organize and give meaning to our experiences (Mateos & Núñez, 2012).

Based on these ideas, this study proposes a narrative-based teaching strategy to facilitate the understanding of the Krebs cycle among university students enrolled in a Biochemistry course.

II. METHODOLOGY.

Three stages were defined for this research..

A. Stage 1: Development of a Narrative-Based Teaching Strategy for the Krebs Cycle.

To develop the strategy, the following elements were considered:

- substrates
- products
- enzymes
- coenzymes
- reactions generating energy through oxidative or non-oxidative phosphorylation
- reactions requiring or releasing water
- CO₂ release
- use of acetyl-CoA

Taking all these components into account, a strategy called "Krebs' House" was developed to facilitate understanding of the structure of the Krebs cycle.

B. Stage 2: Exploratory Stage with Experimental Design.

Presentar la estrategia a estudiantes de los programas de Licenciatura en ciencias naturales (LCN) de la Universidad de Antioquia (UdeA), y de Medicina de la Fundación Universitaria San Martín (FUSM) sede Sabaneta. Para ello, en los grupos de estudiantes de estas universidades, que durante el semestre 2024-1, cursaban bioquímica, se utilizó como alternativa didáctica "La casa de Krebs", posteriormente, una vez terminada la unidad temática, de manera voluntaria, los estudiantes que firmaron un consentimiento informado dieron respuesta a una encuesta, que permitiera extraer información de los puntos de vista de los estudiantes con respecto a la estrategia propuesta. La muestra fue de un total de 14 estudiantes, 8 de la FUSM y 6 de la UdeA.

C. Stage 3: Correlational Stage with Experimental Design.

The teaching strategy was implemented during a regular semester with new groups of Medicine students at FUSM (2024-2).

Based on the evaluation of the strategy's relevance in Stage 2, the didactic alternative was applied to three groups of students through:

- a pre-test before the intervention
- a post-test after the intervention

This allowed assessment of the level of conceptual understanding achieved regarding the structure of the Krebs cycle.

Information was also collected regarding students' perceptions about:

- the teaching strategy
- ease of understanding the cycle
- their own perception of their level of

comprehension The survey included four response categories:

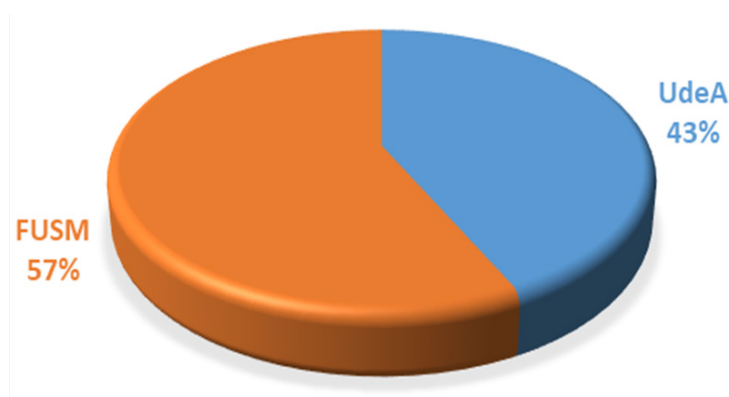
- High – students believe they know the concept and can explain it to classmates
- Sufficient – students believe they know the concept but cannot explain it to others
- Low – students are unsure if they understand the concept
- None – students do not know the concept The sample for this stage consisted of 69 students.

III. RESULTS AND DISCUSSION.

A. Stage 1. The didactic alternative "Krebs' House" was developed in narrative form.

B. Stage 2. When the strategy was applied to students in the 2024-1 semester, the following findings were obtained.

Figura 1. Composición de la muestra de 14 estudiantes.



FUSM students were in their first semester of the Medicine program, while UdeA students were between semesters 5 and 7 of the Natural Sciences Education program.

Tabla 1. Resultados de la encuesta de percepción 2024-1

Percepción previa del ciclo de krebs	El ciclo de krebs tiene demasiada información para aprender y retener, especialmente por lo comentado en el medio por conocidos que se habían enfrentado a dicha ruta.
Expectativas frente al tema	La gran mayoría expresan temor porque esperan un tema demasiado complejo, el cual no podrán dominar, aunque algunos, tienen la esperanza de poder profundizar en la comprensión de la estructura y función del mismo, pues declaran ser conocedores de la importancia que tiene la ruta metabólica en el metabolismo.
Percepción de la estrategia presentada	El 100% de los estudiantes muestran agrado por la metodología utilizada, les sirve mucho, y facilita la comprensión de la estructura del ciclo, se observa que la

observa que la metodología despierta interés por aprender, y facilita la comprensión.

- Agradecen las bondades de la narrativa, al hablar de elementos cotidianos, como el uso de los servicios públicos domiciliarios, permite generar andamiajes adecuados, para una organización estructural más sencilla del ciclo.
- Resaltan en la estrategia, la posibilidad de incrementar la transversalidad de la empatía entre los elementos resaltados por Novak en la enseñanza: estudiante, docente, currículo, el contexto y la evaluación. (Novak, 1988). Y solicitan más alternativas didácticas que los saquen de la monotonía de las clases tradicionales.

Sugerencias para mejorar la alternativa didáctica	El 93% de los encuestados no realiza ninguna sugerencia, el 7% propone profundizar más en la conexión de las enzimas con la estrategia didáctica.
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Nota: encuesta realizada en UdeA y FUSM

C. Stage 3. Comparisons between the pre-test and post-test results showed substantial improvement in all evaluated concepts.

The concept with the highest initial knowledge was cycle intermediates, which reached 100% correct responses after the intervention.

Other improvements ranged from:

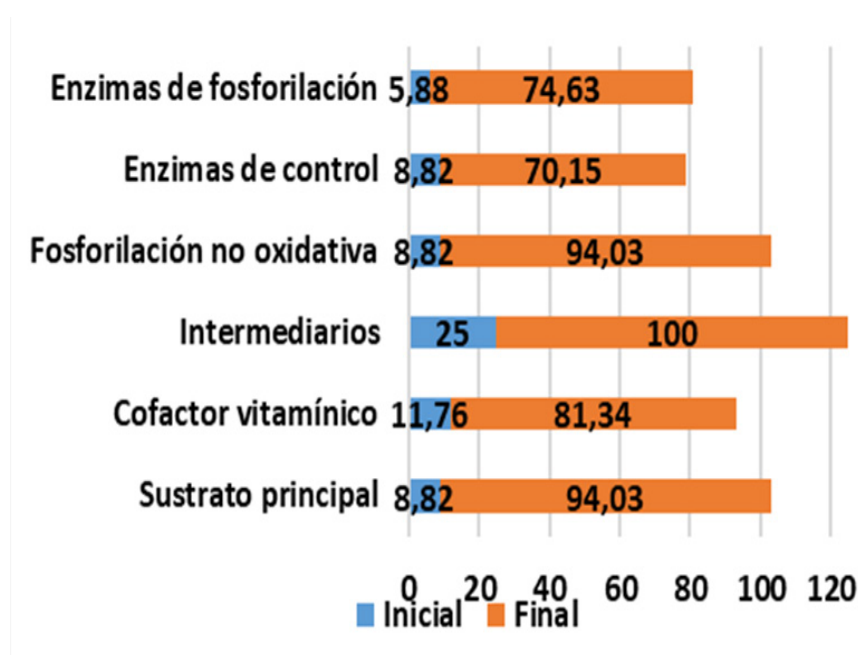
- 61.33% improvement for control enzymes
- 85.21% improvement for oxidative phosphorylation and the main substrate

Overall, students achieved at least 70% understanding for all evaluated concepts.

Para los otros conceptos, se observaron mejorías entre el 61.33% para el concepto de las enzimas de control y el 85.21% para los conceptos de fosforilación oxidativa y sustrato principal, los cuales fueron los conceptos en los que hubo la mayor mejoría porcentual.

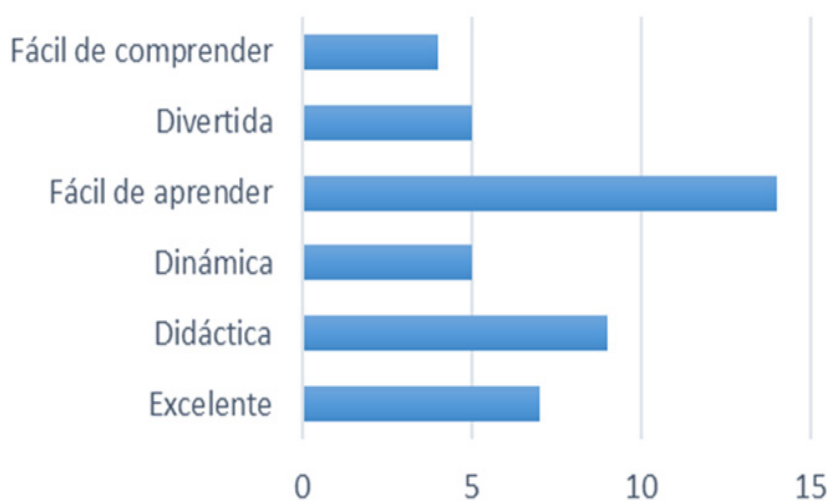
En términos de la utilidad de la alternativa didáctica, se logró que los estudiantes alcanzaran al menos un 70% de comprensión para todos los conceptos, siendo las enzimas de control el concepto que menor comprensión logró con un 70.15% de los estudiantes, y como se dijo anteriormente, los sustratos con un 100% de los estudiantes, fue el concepto más comprendido.

Figura 2.
Comparación entre las actividades inicial y final tras la intervención.



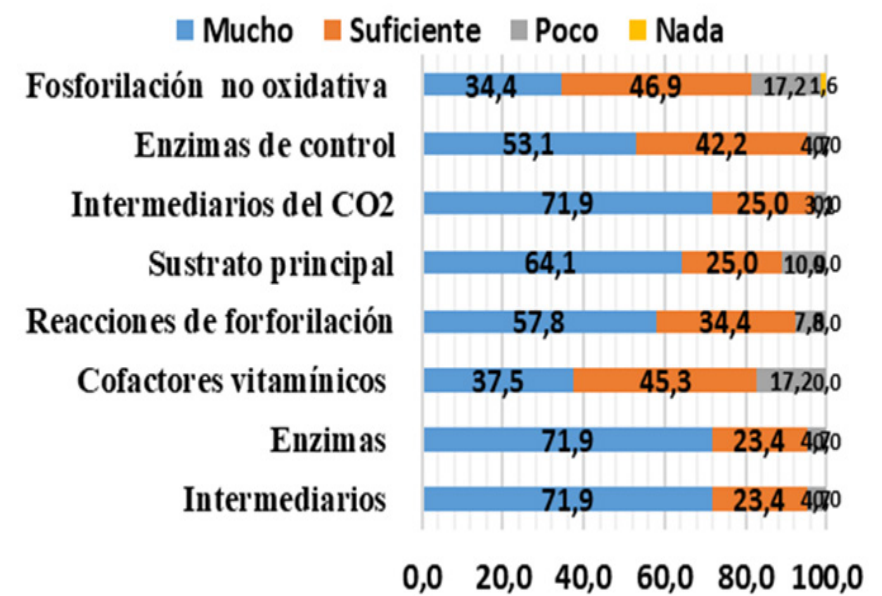
Students described the teaching strategy with adjectives such as:

- excellent
- didactic
- dynamic
- fun
- easy to understand



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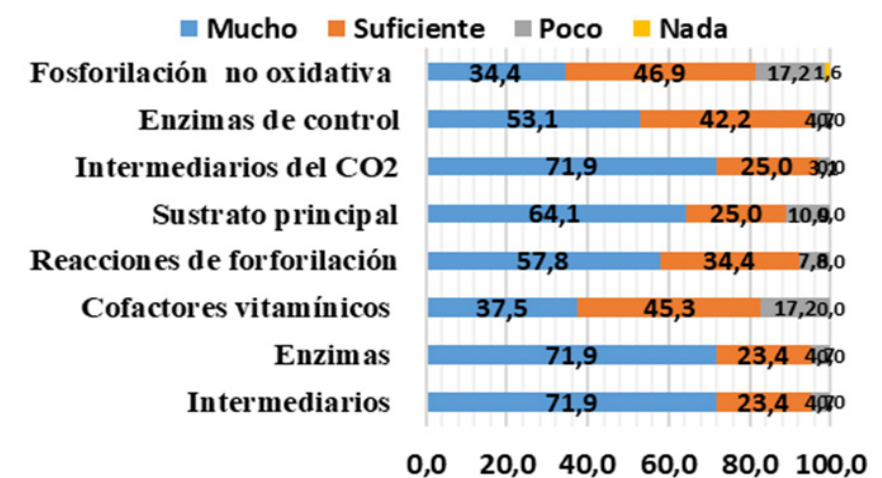
- excellent
- didactic
- dynamic
- fun
- easy to understand



Comparison of Test Scores
Before intervention:

- Mean: 0.83
 - Median: 0
 - Mode: 0
- After intervention:
- Mean: 4.19
 - Median: 4.5
 - Mode: 5

These results indicate significant improvement, demonstrating that the teaching strategy effectively supports understanding of the Krebs cycle structure.



IV. CONCLUSIONS.

The narrative-based teaching strategy "Krebs' House" was developed to facilitate teaching the Krebs cycle.

Students generally perceive the Krebs cycle as difficult to understand due to the large number of terms and details that must be memorized.

However, the "Krebs' House" strategy is viewed as:

- friendly
- easy to understand
- based on simple language
- connected to everyday experiences

This approach facilitates comprehension of the cycle's structure.

The strategy has demonstrated that it helps a high percentage of students understand the structure of the Krebs cycle and provides access to complex information in a simple manner.

Students' perception of their learning is high and aligns with their performance on knowledge assessments, which showed significant improvement after the intervention.

Future research is necessary to better understand the small number of students who still experience difficulties with the strategy and to further refine the teaching approach.

Additional studies may include:

- comparisons with students from other universities
- comparisons across academic programs and educational levels
- deeper analysis of perception vs. actual learning outcomes.

V. ACKNOWLEDGMENTS.

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