

Assessment of the quality of regular exams in the evaluation process in medical sciences

Valoración de la calidad de los exámenes ordinarios en el proceso
evaluativo en ciencias médicas

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ABSTRACT

Background: the quality of medical education is fundamental for training competent professionals capable of responding to societal health demands. A key element in this process is the proper development and application of assessment instruments.

Objective: to assess the quality of the regular exam for the Nervous, Endocrine, and Reproductive System course applied at the Faculty of Medical Sciences of Matanzas during the 2024-2025 academic year.

Methods: a descriptive study with a mixed-methods (quantitative-qualitative) approach was conducted at the Faculty of Medical Sciences of Matanzas, between November and December 2024. 167 regular exams for the Nervous, Endocrine, and Reproductive System course were evaluated. The following methods were used: theoretical (analysis-synthesis, inductive-deductive), empirical (document review), and mathematical-statistical (difficulty index, discrimination coefficient, and reliability using Cronbach's alpha).

Results: the results showed that although the exam exhibited a high level of difficulty, it effectively discriminated among students with different performance levels and achieved acceptable reliability.

Conclusions: the quality of the regular exam for the Nervous, Endocrine, and Reproductive System course applied at the Faculty of Medical Sciences of Matanzas during the 2024 academic year was assessed. The exam met quality standards in terms of discrimination and reliability; it constituted a valid tool for measuring learning in the course.

MeSH: educational measurement; evaluation studies as topic; faculty; students; education, medical.

RESUMEN

Fundamento: la calidad de la educación médica es fundamental para formar profesionales competentes capaces de responder a las demandas sociales de salud. Un elemento clave en este proceso es la correcta elaboración y aplicación de los instrumentos de evaluación.

Objetivo: valorar la calidad del examen ordinario de la asignatura Sistema Nervioso, Endocrino y Reproductor aplicado en la Facultad de Ciencias Médicas de Matanzas en el curso 2024-2025.

Métodos: se realizó un estudio descriptivo, con enfoque cuantitativo en la Facultad de Ciencias Médicas de Matanzas, entre noviembre-diciembre de 2024. Se evaluaron 167 exámenes ordinarios de la asignatura Sistema Nervioso, Endocrino y Reproductor. Se utilizaron métodos teóricos: análisis-síntesis e inductivo-deductivo, empíricos: revisión

documental y matemáticos-estadísticos: índice de dificultad, el coeficiente de discriminación y la confiabilidad mediante alfa de Cronbach.

Resultados: los resultados evidenciaron que aunque el examen mostró un nivel de dificultad alto, logró discriminar eficazmente entre estudiantes con diferentes niveles de desempeño y alcanzó una confiabilidad aceptable.

Conclusiones: se valoró la calidad del examen ordinario de la asignatura Sistema Nervioso, Endocrino y Reproductor aplicado en la Facultad de Ciencias Médicas de Matanzas durante el curso 2024. El examen cumplió con los estándares de calidad en cuanto a discriminación y confiabilidad; constituyó una herramienta válida para medir el aprendizaje en la asignatura.

DeSC: evaluación educacional; estudios de evaluación como asunto; docentes; estudiantes; educación médica.

Received: 11/10/2025

Approved: 01/01/2026

INTRODUCTION

The paradigm shift in medical education, driven by the World Summit on Medical Education in Edinburgh (1993) emphasizes the training of professionals capable of responding both to the needs of their communities and to contemporary scientific and technological challenges.⁽¹⁾ As part of this process, ensuring quality in medical education is essential, not only to improve health and quality of life indicators but also to effectively face the social and academic demands of the 21st century.⁽²⁾

Evaluation in medical sciences transcends mere grading: it is a diagnostic tool that drives the continuous improvement of educational processes. Excellence in medical training demands rigorous and well-designed evaluation instruments that ensure the appropriate measurement of knowledge and skill acquisition, aligned with social needs. Their

effectiveness depends on technical indicators such as validity, reliability, and difficulty and discrimination.^(3,4)

The analysis of evaluation instruments allows for determining whether an exam accurately reflects the knowledge assessed and helps identify strengths and weaknesses. This enables the implementation of continuous improvement strategies in the evaluation process for curriculum strengthening.

Recent national and international studies^(5,6) warn of recurring flaws in written instruments: ambiguous questions or extreme difficulty levels that distort results and limit their pedagogical utility.

In the current Plan E⁽⁷⁾ for the Medicine program, the course plan for the Nervous, Endocrine, and Reproductive System course includes the application of a written regular exam that integrates content from the morphophysiology of these three systems. However, its technical quality must be validated through quantifiable parameters to identify areas for improvement in the evaluation process and design strategies through methodological activities. These activities allow for actions aimed at enhancing the quality of the teaching-learning process and, consequently, student training.

Based on the above, the authors aimed to: assess the quality of the regular exam for the Nervous, Endocrine, and Reproductive System course applied at the Faculty of Medical Sciences of Matanzas in the 2024-2025 academic year.

METHODS

An observational study with a mixed-methods (quantitative-qualitative) approach was conducted at the Faculty of Medical Sciences of Matanzas in the 2024-2025 academic year. The quality of the exam was assessed through the error index, difficulty level, discriminating power, and reliability of the applied instrument. The study population consisted of 167

exams, corresponding to the total number of students who took the regular exam for the Nervous, Endocrine, and Reproductive System course in the 2024-2025 academic year.

Theoretical methods:

- Analytical-synthetic: To arrive at specific analyses and generalizations or vice versa. It was used to decompose the object of study into its essential parts and components within their context, and for interpreting the data provided by statistical instruments. It also allowed for drawing conclusions through synthesis.
- Inductive-deductive: Used to make inferences from the results of each statistical instrument and allowed for information processing.

Empirical methods:

Document review: Applied to identify the characteristics of the exam, considering: course topics (obtained from its program and calendar plan) and exam structure (based on the number of questions and items included). Questions were classified by type, and the number of items evaluated per topic was determined according to the question type.

Mathematical-statistical methods:

The difficulty index, discriminating power using the point biserial correlation coefficient (r_{pbis}), and the α coefficient of Cronbach using the item variance method for reliability were used. Analysis involved whole numbers and percentage distribution to present results in tables. The obtained data were entered into a Microsoft Office 2010 Excel spreadsheet.

Methodology for determining the quality of an evaluation instrument:

1. Creation of a spreadsheet with primary data on each student's exam results. Rows correspond to each student, columns to the results of each item on the evaluated regular exam.

2. Determination of the difficulty index: Calculated through the frequency of errors and the difficulty index itself.
3. Determination of the discriminating power of the exam.
4. Determination of the reliability of the regular exam using Cronbach's α Coefficient.

Calculation of the difficulty index: the proportion of people who answer correctly out of the total examinees; it is inversely proportional to difficulty. The higher this proportion, the lower the difficulty. From a statistical perspective, it is expressed as the difficulty index (p) and, like any index, should be close to a proportion of 0.5-0.6. (6,8,9,10) Its calculation was performed using Backhoff's formula: ⁽¹⁰⁾

$$p = A/N$$

Where:

p : Difficulty index of the question

A : Total correct answers for the question

N : Number of correct answers + Number of errors for the question.

The p values were distributed as: highly difficult less than 0.32; moderately difficult 0.33-0.52; medium difficulty 0.53-0.73; moderately easy 0.74-0.86; and highly easy more than 0.86, according to parameters proposed by Backhoff. ⁽¹⁰⁾

Calculation of discriminating power: allows distinguishing between high- and low-performing students. It also provides a predictive criterion regarding student results, as if the exam and a question measure the same skill or competency, it can be expected that a student with a high total exam score should have a high probability of answering the topics assessed in its questions correctly. To identify it in this research, only the point biserial correlation coefficient (r_{pbis}) was used, via the following formula: ^(5,8,10)

$$r_{pbis} = \frac{\bar{X}_1 - \bar{X}_0}{S_x} \sqrt{\frac{n_1 \times n_0}{n(n-1)}}$$

Where:

\bar{X}_1 = Mean total score of those who answered the item correctly

\bar{X}_0 = Mean total score of those who answered the item incorrectly

S_x = Standard deviation of total scores

n_1 = Number of students who answered the item correctly

n_0 = Number of students who answered the item incorrectly

$n = n_1 + n_0$

According to international standards, the distribution of results for the point biserial correlation coefficient (rpbis) is: ^(5,8,10)

rpbis < 0: Questions with negative discrimination

rpbis = 0 – 0.14: Questions with poor discrimination

rpbis = 0.15 – 0.25: Questions with regular discrimination

rpbis = 0.26 – 0.35: Questions with good discriminating power

rpbis > 0.35: Questions with excellent discriminating power

Calculation of Reliability:

The α Coefficient of Cronbach was used, calculated by the item variance method. It allows determining the internal consistency of an instrument and provides information related to the contribution each question makes to the overall consistency of the exam. The following formula was used: ^(11,12)

$$\alpha = \frac{K}{K-1} \left[1 - \frac{\sum_{i=1}^K S_i^2}{S_x^2} \right]$$

Where:

K: Number of questions in the evaluation instrument

S_i^2 : Variance of the i-th question in the evaluation instrument

S_x^2 : Variance of the grades for each evaluation instrument

This indicator can take values between 0 and 1, where values closer to 1 indicate greater instrument reliability. It is considered: 0 = null reliability; 0.1 to 0.3 = very low reliability; 0.3 to 0.6 = low reliability; 0.6 to 0.75 = moderate reliability; 0.75 to 0.9 = high reliability; greater than 0.9 = very high reliability; and 1 = total reliability.

Data collection was conducted solely by the authors of the work, without personal identification of any student, to ensure confidentiality. The information obtained will not be used for purposes outside the research framework, in accordance with the principles established for all medical research in the Declaration of Helsinki.

RESULTS AND DISCUSSION

The evaluation instrument analyzed was the regular exam for the Nervous, Endocrine, and Reproductive System course of the 2024-2025 academic year, applied in the second period of the first year of the Medicine program at the Dr. Juan Guiteras Gener Faculty of Medical Sciences of Matanzas. All instructional objectives of the course were explored.

It consisted of seven questions, covering all topics in the course's thematic plan according to the study program. It was a mixed-type exam with essay-type questions and objective test-type questions, as shown in Table 1.

Table 1. Thematic area, question types, and number of items per question on the regular exam for the Nervous, Endocrine, and Reproductive System Course. Faculty of Medical Sciences of Matanzas. 2024-2025 Academic year

| No. | Topics | Question type | Number of Items |
|-----|--|--|-----------------|
| 1 | Topic 1. Generalities of the nervous system. Topic 2. Segmental and suprasegmental nervous system. (Anatomy and Embryology content) | Association (Matching) | 7 |
| 2 | Topic 3. Meninges and vascularization. (Anatomy and Histology content) | Association (Matching) | 9 |
| 3 | Topic 4. Functional division of the nervous system: sensory systems, motor systems, and higher nervous activity (Physiology content) | Modified Essay | 3 |
| 4 | Topic 4. Functional division of the nervous system: sensory systems, motor systems, and higher nervous activity (Embryology, Histology, Anatomy, Physiology content) | Simple Selection (Select correct answer) | 7 |
| 5 | Topic 4. Functional division of the nervous system: sensory systems, motor systems, and higher nervous activity (Anatomy and Physiology content) | Simple Selection (True or False) | 10 |
| 6 | Topic 5. Endocrine System (Anatomy, Embryology, Physiology, and Histology) | Short Essay | 11 |
| 7 | Topic 6. Female and Male Reproductive System (Embryology, Histology, Anatomy, Physiology) | Simple Selection (True or False) | 10 |

Source statistical processing

All topics were represented in the exam. Topic 4, "Functional division of the nervous system: Sensory systems, motor systems, and higher nervous activity," was the most heavily represented. This aligns with the stated importance in the Course Plan (P1) of the subject, as this topic contains the greatest number of sub-themes and is allocated the highest number of teaching hours. The exam was designed in a multiple-format style, with objective test-type questions predominating (71.4 %).

The results of the difficulty index are shown in Table 2.

Table 2. Frequency of errors calculated for the regular exam of the Nervous, Endocrine, and Reproductive System Course. Faculty of Medical Sciences of Matanzas. 2024-2025 Academic year

| Questions | Frequency of errors | % | Passing Scores | % |
|-----------|---------------------|----|----------------|----|
| 1 | 130 | 78 | 37 | 22 |
| 2 | 108 | 65 | 59 | 35 |
| 3 | 90 | 54 | 77 | 46 |
| 4 | 59 | 35 | 108 | 65 |
| 5 | 77 | 46 | 90 | 54 |
| 6 | 132 | 79 | 35 | 21 |
| 7 | 72 | 43 | 95 | 57 |
| Examen | 115 | 69 | 52 | 31 |

Source: statistical processing

It is confirmed that there was a high percentage of errors on the regular exam for the course (69 %), with questions 1, 2, 3, and 6 showing more errors than correct answers and error rates exceeding 50 %.

Table 3 presents the difficulty index of the exam based on data from the statistical processing.

Table 3. Difficulty index calculated for the SNER Exam. Faculty of Medical Sciences of Matanzas. 2024-2025 Academic year

| Questions | Difficulty Index (p) | Result Analysis |
|-----------|----------------------|----------------------|
| 1 | 0.21 | Altamente difícil |
| 2 | 0.35 | Medianamente difícil |
| 3 | 0.46 | Medianamente difícil |
| 4 | 0.64 | Dificultad media |
| 5 | 0.53 | Dificultad media |
| 6 | 0.20 | Altamente difícil |
| 7 | 0.56 | Dificultad media |
| Examen | 0.31 | Altamente difícil |

Source: statistical processing

Regarding the exam's difficulty index, it is observed that those questions with the highest frequency of errors (1 and 6) showed a highly difficult difficulty index, and two questions (2 and 3) were moderately difficult. The recommended range for this index is between 0.53 and 0.73. The results for questions 1, 2, 3, and 6 impacted the overall exam difficulty index, which was also highly difficult for the students. Based on the expected frequency distribution of correct answers, approximately 5 % of students should find the exam easy, 20 % moderately easy, 50 % of medium difficulty, 20 % moderately difficult, and 5% difficult. In the administered exam, 28.6 % was highly difficult, 28.6 % was moderately difficult, and 42.8 % was of medium difficulty.

The discriminating power of the regular exam for the Nervous, Endocrine, and Reproductive System is presented in Table 4.

Table 4. Discriminating power calculated via the point biserial correlation coefficient (rpbis) of the exam. Faculty of Medical Sciences of Matanzas. 2024-2025 Academic year

| Questions | Point biserial correlation coefficient (rpbis) | Result analysis |
|-----------|--|--------------------------------|
| 1 | 0.69 | Excellent discriminating power |
| 2 | 0.84 | Excellent discriminating power |
| 3 | 0.84 | Excellent discriminating power |
| 4 | 0.78 | Excellent discriminating power |
| 5 | 0.60 | Excellent discriminating power |
| 6 | 0.54 | Excellent discriminating power |
| 7 | 0.93 | Excellent discriminating power |
| Exam | 0.74 | Excellent discriminating power |

Source: statistical processing.

Despite its quality being compromised by being a highly difficult exam with a high frequency of errors, all of its questions demonstrated excellent discriminating power.

The reliability of the aforementioned exam is shown in Table 5. The results indicate that the exam exhibited reliability within acceptable parameters and is a reliable instrument for assessing knowledge and skills in this course.

Table 5. Reliability calculated for the regular exam. Faculty of Medical Sciences of Matanzas. 2024-2025 Academic year

| Exam | Total of Items | Sum of Item Variances | Total Variance | Cronbach's Alpha Coefficient |
|------|----------------|-----------------------|----------------|------------------------------|
| | 7 | 5.75 | 17.1 | 0.77 |

Source: statistical processing

By evaluating the quality of a written exam, effective evaluation instruments can be obtained to measure the quality of the teaching-educational process and establish guidelines

for its improvement, all through adequate methodological work within the course collective and faculty preparation.

Upon evaluating the exam's structure, it can be observed that objective test-type questions predominated (71%). This result coincides with the work of Fardales *et al.*⁽¹³⁾ and Carrazana Silvera *et al.*⁽¹⁴⁾ in both studies, 80% of the analyzed exam structures corresponded to objective tests of various formats such as multiple-choice questions, true/false tests, or matching exercises. This type of question is preferred by many evaluators for its advantages, which include :⁽¹⁵⁾

- Ensuring objectivity and generally increasing the instrument's reliability and validity.
- Increasing the variety of aspects to be evaluated in a short time and with minimal supervision.
- Facilitating ease and speed of grading, allowing for prompt communication of student results.
- Providing feedback to both the teacher and students, highlighting strengths and weaknesses.
- Statistical analysis is relatively straightforward and provides reliable information.

Despite these advantages, they also have their disadvantages, necessitating careful preparation. These include :⁽¹⁵⁾

- Their preparation requires considerable time and practice to avoid poorly constructed questions. This difficulty increases when aiming to assess complex aspects of interpretation or problem-solving, which require prior student training.
- They provide students with information and cues not available in a real-life situation.
- They require adopting specific conditions to account for correct answers that could be guessed by chance.

In the difficulty index of the analyzed instrument, moderately difficult and highly difficult questions predominated, aligning with those questions showing the highest frequency of errors on the exam. This led to the instrument's overall difficulty index (0.31) being

classified as highly difficult. According to Backhoff Escudero *et al.*,⁽¹⁰⁾ exam difficulty should range between 0.53 and 0.73, i.e., a medium difficulty index.

The results of the analysis of the point biserial correlation coefficient (rpbis) demonstrate that, despite the exam being highly difficult, 100% of the instrument's questions discriminated excellently between high- and low-performing students, as shown in Table 4. According to several authors,^(5,8,10) exam questions should remain within this range of excellent discrimination. This finding contradicts the result of the discrimination coefficient analysis for those highly difficult and moderately difficult questions, which should not be used in an exam; with easy questions, a high number of students will achieve high grades, and with difficult questions, a high number will achieve low grades. This result aligns with the research conducted by Rodríguez Acosta *et al.*⁽⁸⁾

Torres⁽¹²⁾ in "Reliability of Scales: Interpretation and Limitations of Cronbach's Alpha," establishes that the reliability of a test is associated with the consistency or stability of a measure. The alpha coefficient as a measure of internal consistency was proposed in 1951 by the American psychologist Lee Joseph Cronbach, known for his work in psychometrics and reliability measurement.

Reliability is the quantitative expression of the reproducibility with which an instrument measures the same attribute. Through it, result stability is achieved. Its use provides internal consistency to the evaluation instrument. Cronbach's Alpha Coefficient is the most widely used globally, as it provides an effective measure of the exam's internal consistency and can be used with different question formats.^(12,13)

In the present research, the reliability analysis of the evaluation instrument showed it to be reliable, as the value of α (Cronbach's Alpha) fell within the range of high reliability. Therefore, it can be stated that the instrument has internal consistency. This result agrees with the research conducted by Gómez Trujillo *et al.*⁽⁹⁾ The interpretation and limitation of Cronbach's Alpha align with the aforementioned research by Torres.⁽¹²⁾

Scientific contribution

This work provides methodological foundations regarding the technical quality of an exam and, consequently, the quality of a course's evaluation process. By analyzing its psychometric variables (difficulty index, discriminating power, and reliability), it allows for the identification of problematic items or questions and enables specific adjustments to future evaluation instruments. This guides the improvement of the teaching-learning process for the course.

CONCLUSIONS

The analysis of the various indicators of the regular exam for the Nervous, Endocrine, and Reproductive System course supports that it meets quality standards in terms of discrimination and reliability, constituting a valid tool for measuring learning in the course. However, it is recommended to implement strategies to adjust the difficulty level for future applications para disminuir la dificultad en ciertos temas y fortalecer la preparación de los alumnos, para el nivel general del desempeño académico.

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Declaration of interests

The authors declare no conflicts of interest.

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