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*Translated from the original in spanish*

**Original article**


## **ATJ Matrices, tools for predicting the validity of a scientific result in Physical Culture**

**Matrices ATJ, herramientas para pronosticar la validez de un resultado científico en la Cultura Física**

**Matrizes ATJ, ferramentas para prever a validade de um resultado científico na Cultura Física**

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### **ABSTRACT**

The methods of prognosis are currently used to estimate the occurrence of an expected result, ie, offer the probability of presentation of a quality or process, however, its use is still insufficient in the context of physical culture, so provide a new method and its application methodology, is important as a qualitative filtering process. The aim of this article is to present the ATJ matrices as tools for the prognosis of the validity of a scientific result in Physical Culture. To achieve it, methods such as: opinion poll,



unstructured interview, analytical-synthetic, inductive-deductive, analysis of bibliographic sources, systemic-structural-functional, specialists' criteria and statistical-mathematical were used. As a preliminary result, it is possible to obtain a matrix arrangement called ATJ, where four matrices that respond to dimensions are declared; each one with its respective indicators and valuation scales that make it possible to obtain a final evaluation criterion. The procedure provided to the researcher for the application of the matrix arrangement is easy to understand and enables qualitative work to obtain the expected result.

**Keywords:** ATJ matrix; Prognosis of validity.

## RESUMEN

Los métodos de pronósticos en la actualidad son utilizados para realizar la estimación de ocurrencia de un resultado esperado, es decir, ofrecen la probabilidad de presentación de una cualidad o proceso, sin embargo, su utilización resulta aún insuficiente en el contexto de la Cultura Física, por lo que aportar un nuevo método y su metodología de aplicación, reviste importancia como un proceso de filtración cualitativo. El objetivo del presente artículo se enmarca en exponer las matrices ATJ como herramientas para el pronóstico de la validez de un resultado científico en la Cultura Física. Para lograrlo, se emplearon métodos, tales como: sondeo de opinión, entrevista no estructurada, analítico-sintético, inductivo-deductivo, análisis de fuentes bibliográficas, sistémico-estructural-funcional, criterio de especialistas y estadístico-matemático. Como resultado preliminar, se logra obtener un arreglo matricial denominado ATJ, donde se declaran cuatro matrices que responden a dimensiones; cada una con sus respectivos indicadores y se brindan escalas valorativas que posibilitan obtener un criterio evaluativo final. El procedimiento que se proporciona al investigador para la aplicación del arreglo matricial es de fácil comprensión y posibilita el trabajo cualitativo para la obtención del resultado esperado.

**Palabras clave:** Matrices ATJ; Pronóstico de validez.

## INTRODUCTION

In the process of evaluating and selecting alternative solutions to certain problems under research, the use of mathematical algorithms is common. Given this reality, [Sánchez \(2003\)](#), highlights that there are also heuristic procedures with solid technical support and that they are the product of practice in the evaluation and selection of alternatives.

In the specialized literature, authors such as [Kepner and Tregoe \(1981\)](#), [Ochoa \(1981\)](#), [Sánchez \(1987\)](#), [Majaro \(1988\)](#), [Covey \(1989\)](#), among others, propose the use of matrix arrangements because of their low implementation cost, reduced application time and easy understanding for participants or users. These are used to estimate the occurrence of an expected result. [Osorio, \(2016\)](#), emphasizes this type of tool as an instrument that helps to prepare, in a more effective way, for the coming events, where predictive exercises can have an important weight, seen from the strategic perspective. In this sense, [Astigarraga, \(2016\)](#), emphasizes the future challenges of strategic foresight, with the use of matrices.



In another context, *Constaín et al., (2014)*, in a study carried out at the Universidad Pontifica de Medellín, (Colombia), propose the assessment of the validity and usefulness of the EAT-26 scale for the evaluation of eating behavior risks, through the use of the correlation matrix for a factorial assessment. The previous appreciations are framed firstly in the business sector and in another order in the psychological field.

The practice represents the starting point of knowledge and its transformation constitutes the final objective of the whole cognitive process, as several authors state, among which Guelmes and *Carballo (2017)* stand out. When a research purpose is pursued, it is important to have clarity in the possible result to be achieved, so the analysis of what exists in scientific theory, its limitations, insufficiencies and deficiencies have a marked significance.

*Saborido, (2018)*, emphasizes the importance of increasing knowledge and for this purpose insists that it is vital to raise the quality, quantity and relevance of research, as well as the application of scientific methods. This knowledge obtained should not remain static, it needs to be disseminated as *Muñoz et al., (2019)* emphasizes, as well as the use of novel tools to predict the qualities of one or another process.

By intervening, the researcher who is concerned with finding a solution to scientific and pedagogical problems becomes an agent of change and his work contributes to facilitating the associated processes.

In the research developed in the educational sciences, the scientific results sought, such as: models, strategies (didactic, methodological, among others), systems, programs, methodologies, just to mention a few, are not frequently predicted if the result of the proposal is valid or not; this problematic situation originated the interest of the authors, given the need to face this lack.

The main purpose or objective of this research is then framed in offering a tool for the prognosis of the validity of a scientific result in Physical Culture. Its importance lies in presenting the ATJ matrices as a filtration process, which establishes a matrix arrangement to predict the validity of the scientific result.

## **MATERIALS AND METHODS**

*Guelmes and Carballo, (2017)*, argued about the dialectical-materialistic character of an research, since this cannot be reduced to the study of the method in its restricted instrumental sense, but has a wide sense, so it is an inherent part of the whole research process.

Taking into consideration the referred conjectures, the authors of this article, supported by the dialectical-materialistic, managed to conduct the process of elaboration of the matrix arrangement, from a renewed perception, capable of dealing with phenomena in constant movement and transformation. In order to assume this perspective, they also measured the arguments of *Silva, (2016), cited by Ramos, (2019)*, who proposes as one of the important relationships in the orientation of this process the didactic attitude for evaluation, the didactic research conciliation and the argumentative attitude for integration.



This qualitative study was carried out taking as a unit of analysis the science of Administration applied to the context of Physical Culture, specifically in the use of matrices. It was carried out at the beginning of 2019, given the need to use an instrument or tool to forecast the validity of a strategy as a scientific result in the context of Physical Culture.

In its development, methods were used, such as:

- Opinion poll: method of information collection used to diagnose the use of tools for the prognosis of validity of a scientific result in the context of Physical Culture.
- Unstructured interview: it was used in the diagnosis as an instrument of the opinion poll.
- Analytical-synthetic: it made possible the systematization of the theoretical foundations that support the use of matrices as tools to forecast the validity of a research result.
- Inductive-deductive: it was used to identify the problem, make interpretations, and explore possible ways of solution until arriving at the conclusions of the study.
- Analysis of bibliographic sources: an analysis of bibliographic sources was carried out to know the specifications of each one of the matrices and their corresponding dimensions.
- Systemic-structural-functional: it allowed favoring the organization and logic of the study, as well as the establishment of the interrelations between the different matrices that compose the matrix arrangement called ATJ.
- Specialist criteria: it made possible the validation of the matrix arrangement ATJ with the use of the unstructured interview technique.
- Statistical-mathematical processing: descriptive statistics (average) were used.

As a starting point for the research, a diagnosis was made to determine to what extent the prognostic methods used in Physical Culture studies make it possible to predict the validity of a scientific result. In this sense, it was carried out an opinion poll with researchers of the doctoral theses defended and approved in the last two years. From a universe of 41 researchers, it was selected a sample, at random, of 34 subjects that represent 82.9 %.

With the intention of obtaining an overview of the subject of study, an unstructured interview was applied to them which was fundamentally centered on knowing if, in the researchers carried out, matrices were used as methods of prognosis. If so, it was inquired about the objectives pursued in each case, with the intention of revealing if in any of them they determined the validity of the proposed scientific result. With this interview as an instrument of the opinion poll, it was possible to obtain a variety of answers that made it possible to verify that:



In the context of the Physical Culture, the researches that are carried out are supported by mathematical statistical methods of proven authenticity and it is an aspect of scientific rigor in the analysis of data, either of a diagnosis or of a practical application.

The use of matrices for this purpose has taken on particular relevance and among the most commonly used are:

- SWOT matrix: to carry out an internal and external diagnosis through the analysis of weaknesses, threats, strengths and opportunities to make a crossover.
- Chanlat matrix: to determine the expected effectiveness of a scientific result as a prognosis method, typical of non-parametric statistics.
- Taxation matrix: to relate the subjects of the curriculum with the learning results declared in the exit profile and among its purposes is to make curricular decisions and design improvement plans.
- OPA matrix: this matrix has the objective of carrying out a comparative analysis between the alternative solutions that are proposed and the existing ones in order to establish relationships between components, indicators, variables, and categorize them.

These matrices are characterized by being double-entry tables that relate variables, indicators or dimensions, which depend on the purpose in each case.

The matrices used by the interviewees do not constitute an instrument or tool that legitimizes and predicts the validity of a scientific result in this area of knowledge as a way to diversify the use of these methods.

The results obtained with the present diagnostic demonstrate the need to contribute to mitigate this deficiency and to present, in a concise manner, some resources that make it possible to reach the desired state through an accurate prognosis in a creative way.

The methodological procedure used in the elaboration of the tool was specified in the following steps:

1. Identification of the need: here the diagnosis was carried out that made it possible, determined the need for attention to the demand.
2. Methodological meeting: the dimensions, their corresponding indicators and the description of each one of them were established.
3. Design of the matrix arrangement: conception and elaboration of the matrix arrangement in correspondence with the demand.
4. Validation of the matrix arrangement ATJ: it was submitted to the evaluation by the specialists.

The proposed ATJ matrices respond to a matrix arrangement that emerged from the research of [Sánchez \(2003\)](#), who began by estimating three fundamental dimensions, with their corresponding indicators, distributed in each of the matrices. For the design of this matrix arrangement, three basic conditions were required:



1. Technical feasibility: the design should not incorporate any unknown or inapplicable technology. However, feasible technological innovations can be included.
2. Operational feasibility: the designed arrangement must be capable of surviving once it is in operation.
3. Flexibility: easy to understand and adapt; can be satisfied only if three requirements are met: first: subject to modification, according to the needs of the studied context; second: it must include simple and consistent operational processes; third: the resulting matrix arrangement must fulfill the purpose for which it was created.

Even though these basic conditions are required, the design achieved respected the essence of its content, marked by being a tool for prognosis of the validity of a scientific result in order to influence the decision making, regarding it, characterized by its credibility and applicability.

The enunciated prognosis method resulted from the adaptations made by Morales, Hernández and Otero, who incorporated a fourth matrix (D), with their respective indicators, aligned to the context of Physical Culture and to the objective of the evaluation of a scientific result. This incorporation was made when considering the distinctive features that characterize the studied context, as well as the benefits that it has to bring given the differentiation. The product of this process of adjustment or reorganization became concrete in the ATJ matrices, name that synthesizes the initial patronymic of the authors.

Its content is set out below (Table 1).

**Table 1.** - ATJ matrices for prognosing the validity of a scientific result

<b>MATRIX-A</b>	<b>MATRIX-B</b>	<b>MATRIX-C</b>	<b>MATRIX-D</b>
<b>DIMENSION</b>	<b>DIMENSION</b>	<b>DIMENSION</b>	<b>DIMENSION</b>
<b>FEASIBILITY</b>	<b>CONSISTENCY</b>	<b>RELIABILITY</b>	<b>LEGITIMITY</b>
<b>INDICATORS</b>			
<b>Pertinence</b>	Participative	Reliability	Justification
<b>Operativity</b>	Transformer	Parpase	Authenticity
<b>Applicability</b>	Coherence	Suitability	Utility
<b>Funcionability</b>	Objectivity	Logic	Transcendence





## RESULTS AND DISCUSSION

This matrix arrangement relies for its effectiveness on participatory heuristic techniques that are aimed at obtaining a satisfactory solution. They are simple and useful techniques in their application, which allow modifications that meet the requirements of research and practice itself. ATJ matrices are described below.

The A-matrix responds to the feasibility dimension, quality of feasibility (which is likely to be realized or to become concrete, thanks to its circumstances or characteristics). According to [Sánchez, \(2003\)](#), Feasibility is understood as the capacity for realization. In the case of scientific research, this concept is related to the possibility of carrying it out in practice or not. For this reason, it is particularly important that this precept be fulfilled.

To achieve the evaluation of the feasibility dimension, the indicators described below were considered:

- **Pertinence:** oriented towards an objective of the career curriculum.
- **Operativity:** access to the implementation of the actions that compose it.
- **Applicability:** provides adequate actions for the achievement of the predetermined goal.
- **Functionality:** practice and usefulness for the performance of its actions.

The B-matrix responds to the consistency dimension, it is the quality of what is stable, coherent and does not disappear easily. It is used in different ways, according to the context. In the field of research and statistics, we speak of internal consistency to mention the correlation that exists among the different components of the same work or test. Another of its meanings refers to the coherence that exists between the elements that form part of a whole.

The evaluation of this dimension was carried out through the indicators:

- **Coherent:** facilitates the analysis of the connections between the components.
- **Transformative:** allows changes to be made in the intervening context.
- **Formative:** favors academic training in terms of the object studied.
- **Objective:** it is projected, executed and controlled on real bases of materialization.

The C-Matrix responds to the reliability dimension, it is recorded as reliable, dependable and probable quality. It also refers to stable, safe, consistent and predictable results. For reliability, structural corroboration is proposed, which consists of gathering data and information and with them establishing the links of a whole that is supported by parts of the evidence.

The indicators arranged for the evaluation of the reliability dimension are:

**Participation:** it demands and depends on the active and committed participation of those involved.





- Purpose: defines the future state to be achieved.
- Suitability: appropriate to meet the objective for which it was designed.
- Logic: highlights the knowledge you want to establish.

The D-matrix responds to the dimension of legitimacy, character, quality or condition of what is legitimate. This is accepted by the scientific, philosophical, and cultural or sports community, with respect to whoever constructs or defines the discourse as competent, that it is in conformity with the laws and that, therefore, it is licit. Likewise, by extension, the adjective legitimate is usually used to refer to the conformity or truthfulness of a matter or thing. In this research, it is appropriate to assess the originality and scope of the proposal from its nature.

This dimension is evaluated by means of the indicators:

- Justification: it sets out the reasons that make it necessary.
- Authenticity: it shows the distinctive features that characterize it.
- Utility: it provides benefits for the context in which it was applied.

Transcendence: designed for the professional training of students of Physical Culture, with possibilities of application in other contexts (Table 2).

**Table 2.** - Description of indicators by dimension of ATJ matrices

Dimensión	Indicadores	Descripción del indicador
<b>Viabilidad</b>	Pertinencia	Orientación hacia un objetivo predeterminado
	Operatividad	Accede a la puesta en práctica de sus componentes
	Aplicabilidad	Proporciona un accionar para cumplir con el objetivo dispuesto
	Funcionalidad	Utilizable para el desempeño eficaz de sus operaciones
<b>Consistencia</b>	Participativo	Demanda y depende de una participación activa y comprometida de los involucrados
	Transformador	Permite lograr cambios en el contexto que interviene
	Coherencia	Facilita el análisis de las conexiones entre los componentes
	Objetividad	Se proyecta, ejecuta y controla sobre bases reales de materialización
<b>Confiabilidad</b>	Fiabilidad	Probabilidad de cumplir con el funcionamiento para un fin determinado
	Finalidad	Define el estado futuro que se desea alcanzar
	Idoneidad	Apropiado para cumplir el objetivo para el que fue diseñado
	Lógica	Evidencia el razonamiento en el proceder utilizado
<b>Legitimidad</b>	Justificación	Expone los motivos que lo hacen necesario
	Autenticidad	Manifiesta rasgos distintivos que lo caracterizan
	Utilidad	Proporciona beneficios para el contexto donde ha de aplicarse
	Trascendencia	Posibilidad de aplicación en el contexto estudiado y en otros



The creation of ATJ matrices as a prognostic method to validate a scientific result allowed the establishment of a valuation scale for each of the indicators of the different dimensions (Table 3). These values are processed to determine the average per dimension (PD) and to apply the corresponding evaluation criterion (Table 4).

**Table 3.** - Scale of assessment of dimensional indicators (ATJ matrices)

<b>Scale of assessment</b>	
<b>Excellent</b>	10
<b>Very good</b>	9
<b>Good</b>	8
<b>Not so good</b>	7
<b>Insufficient</b>	6

**Table 4.** - Evaluation criteria for the dimensions of ATJ matrices

<b>Evaluation criteria for the dimensions</b>	
<b>PD &gt; 8</b>	It is fulfilled
<b>6 ≤ PD ≤ 8</b>	Requires modifications
<b>PD &lt; 6</b>	It is not fulfilled
<b>PD</b>	<b>Dimension average</b>

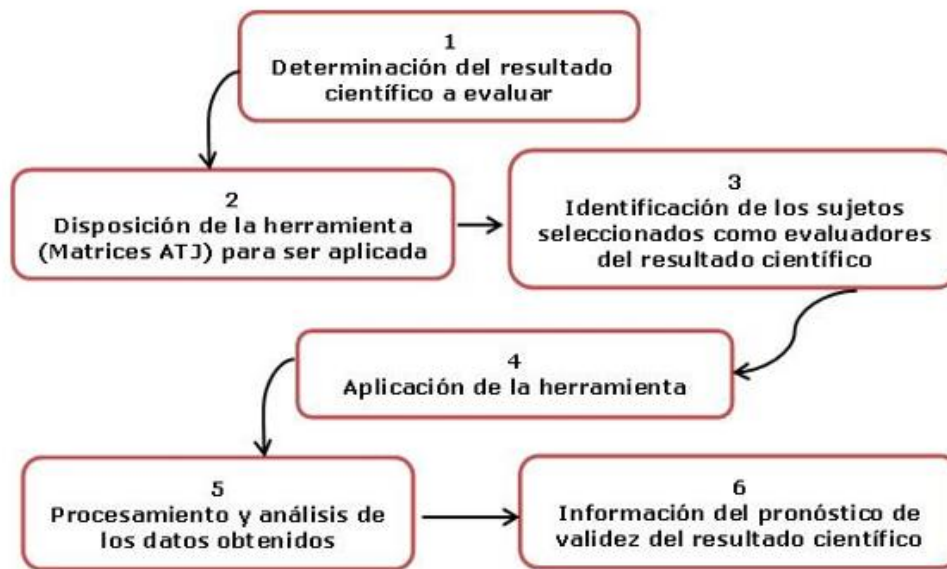
The integration of the averages of these four dimensions (feasibility, consistency, reliability and legitimacy), makes it possible to know the general average reached as a prognosis of the validity of the scientific result (Table 5).

**Table 5.** - Evaluation criteria of the general average of the ATJ matrixes

<b>Evaluation criteria of the general average</b>	
<b>PG ≥ 8</b>	It is valid
<b>PG &lt; 8</b>	Not valid
<b>PG</b>	<b>Overall average</b>

A six-step procedure was determined for the application of ATJ matrices (Figure 1).





**Fig. 1.** - Procedure for the application of ATJ matrices

For the selection of the evaluators, it was considered what was affirmed by [Ortiz and Sanz, \(2013\)](#), [quoted by Castellanos, \(2013\)](#), who establishes the units of information collection and the type of informant or evaluator. In this case, it is recommended to assume the criteria of convenience for the selection of the informants or evaluators, which has the particularity that occurs for its own reasons and that responds to the demands of the research in question. For example:

- To be a teacher of a certain discipline or specialty.
- A certain number of years of experience that proves to be considered as an evaluator.
- Show willingness to participate in the study.

Instruments established for the application of ATJ matrices (Table 6).



**Table 6.** - Instruments established for the application of ATJ matrices

MATRIZ-A		Evaluators										
DIMENSIÓN FEASIBILITY	n1	n2	n3	n4	n5	n6	n7	n8	n9	...	nn	
Pertinence												
Operativity												
Aplicability												
Funcionability												
<b>Average</b>												
<b>Overall average of the Feasibility dimension:</b>												
MATRIZ-B		Evaluators										
DIMENSIÓN CONSISTENCE	n1	n2	n3	n4	n5	n6	n7	n8	n9	...	nn	
Participative												
Transformer												
Coherence												
Objectivity												
<b>Average</b>												
<b>Overall average of the dimension Consistence:</b>												
MATRIZ-C		Evaluators										
DIMENSION RELIABILITY	n1	n2	n3	n4	n5	n6	n7	n8	n9	...	nn	
Reliability												
Purpose												
Suitability												
Logic												
<b>Average</b>												
<b>Overall average of the Reliability dimension:</b>												
MATRIZ-D		Evaluators										
DIMENSION LEGITIMACY	n1	n2	n3	n4	n5	n6	n7	n8	n9	...	nn	
Justification												
Authenticity												
Utility												
Transcendence												
<b>Average</b>												
<b>Overall average of the Legitimacy dimension:</b>												
<b>GENERAL AVERAGE OF THE PROGNOSIS OF VALIDITY:</b>												

Where  $n$  represents each of the subjects selected as evaluators of the scientific result and the sub-index means the order of the subjects.

### Validation of the ATJ matrix arrangement

In this validation, 27 selected specialists in Physical Culture took part, in addition, the criteria of the authors Fleitas, Mesa and Guardo (2013) in the field of Physical Culture were taken into account. Of them, 21 PhDs in Science and six with the academic title of Master of Science. These specialists studied the proposal and expressed their evaluation criteria through an unstructured interview, they qualified the proposal as very adequate in terms of

- Theoretical consistency and practical applicability
- The contribution in the solution of an existing problem about the prognosis of the validity of a scientific result in the context of Physical Culture.
- The feasibility of application of the matrix arrangement.
- The operational ease in its use.



- The flexibility in its conception.
- Fulfillment of the purpose for which it was created.

In general, the application of the specialists' criteria showed very favorable results. From these, we proceed to make the practical application, where the usefulness of the ATJ matrix arrangement is verified and will be presented in a future article.

Some suggestions for the use of ATJ matrixes:

1. Study of the tool and its application procedure
2. Selection of evaluators. Consider the number (as oriented by the literature for these cases) and the level of expertise of these as a guarantee of the credibility of the results.
3. Apply the informed consent technique to the evaluators in order to establish the commitment and conformity of their participation.
4. Use at least one facilitator (preferably a member of the research team).
5. Apply preferably on an individual basis. If it is a group, the individual evaluation of each evaluator subject should be considered.

## CONCLUSIONS

The study carried out made possible to consider different matrices and edges of the prognostic methods, which analysis meant the preamble of the present research that had as trigger the materialization of the matrix arrangement ATJ, which is verified as a tool of prognosis of the validity of a scientific result, in the context of the Physical Culture.

The validation of this matrix arrangement by specialists' criteria, with the use of the application procedure, showed the importance and transcendence of the prognostic tool. It is distinguished for being used as a base model and adapted to research needs, hence its flexibility. Another distinctive feature is its instrumental character for the predicted evaluative estimation, which selection of alternatives is a qualitative appreciation.

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#### **Conflict of interests:**

The authors declare not to have any interest conflicts.

#### **Authors' contribution:**

**Ana María Morales Ferrer:** Conception of the idea, literature search and review, instrument making, instrument application, compilation of information resulting from the instruments applied, statistic analysis, preparation of tables, graphs and images, database preparation, general advice on the topic addressed, drafting of the original (first version), review and final version of the article, article correction, authorship coordinator, translation of terms or information obtained, review of the application of the applied bibliographic standard.



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