# Validation of the pedagogical strategy for the formation of the competence entrepreneurshipin high education through the use of neutrosophic logic and Iadov technique

**Noel Batista Hernández [1], Norberto Valcárcel Izquierdo[2], Maikel Leyva-Vázquez[3], Florentin Smarandache[4]**

[1]MSc professor in senior high education, Havana, Cuba
[2] Ph. D.Professor in "Enrique José Varona" PedagogicalSciencesUniversity, Havana, Cuba.
[3] Universidad de Guayaquil, Facultad de Ciencias Matemáticas y Físicas, Guayaquil Ecuador.Email: mml leyvaz@gmail.com
[4]Mathematics & Science Department, University of New Mexico.705 Gurley Ave., Gallup, NM 87301, USA.e-mail: fsmarandache@gmail.com

**Abstract**.The objective of this work is to validate the implementation of the pedagogical strategy for the development of the competence to undertake as a contribution to the comprehensive education in senior high students in “10 de Octubre” borough in Havana, Cuba.The research seeks to increase scientific knowledge; so it is necessary to objectify the requirements of validity and reliability on which it is based. Validity is understood as the consistency and stability shown by the results of research when applying different demonstration methods, based on the assumption that these are conceived and structured with the capacity to determine and measure.Reliability allows establishing that the conclusive results of the research are balanced and refers to the degree to which the same action submitted to a measurement by the same investigative or different subject produces similar results. For the authors, investigative reliability constitutes the degree of stability that when applying the validation they tend not to vary.In order to sustain the derivations of the development of this strategy, a survey instrument was applied to training and recipients whose results were evaluated through a complex methodology, which integrates the Iadov technique and the neutrosophic logic, determining the transcendences and strategic training repercussions and its consequences on the performers of senior high education.

**Keywords**:Iadov, Neutrosophic, Indeterminacy, Group Satisfaction Index

## 1 Introduction

The systematization of several definitions led the authors to define the entrepreneurship competence as the complex and systemic set of knowledge, abilities, skills, attitudes and values that interact synergistically and make viable the autonomous and effective performance of the individual, by providing it with tools to create, manage, interpret, understand and transform the social environment with a critical, proactive and innovative vision, sustaining a life model, personal development in present and in future[1].

The formation of competence to undertake makes the learner a protagonist of the community context by enabling the application of knowledge through the selection of methods, procedures and disjunctive proposals, which mobilize the cognitive and attitudinal structures developed during the process, complex arrangements that pay tribute to the integral development of student[2].

In order to contribute to the development of the comprehensive education of the student of senior high education, this pedagogical strategy for the development of entrepreneurship competition was conceived and applied. This moment is concretized in the strategic performance of modeling of ventures, based on proposals resulting from the student's identification of possible solutions to problems that arise from the social demands of the surrounding environment[3].

In the provisions of stages and phases, students are encouraged in the search of alternatives, of conformation of factical schemes, which allows the application, in the social context, of knowledge, skills, attitudes,and values.

The determination of the actors' assessment of the strategy's impact makes up a significant indicator of the validity of the strategy. This action needs to validate the results by the investigation and with this purpose, the Iadov technique is applied. Iadov constitutes an indirect way to study of satisfaction, in this case, the actors' developers and evaluators of the process and the addressees[4].
Iadov's technique uses, as suggested by the original method[5], the related criteria of answers to intercalated questions whose relationship the subject does not know, at the same time the unrelated or complementary questions serve as an introduction and support of objectivity to the respondent who uses them to locate and contrast the answers.The results of these questions interact through what is called the "Iadov Logical Table"[6, 7]. In this paper, the satisfaction of emitting actors (teaching staff and training activity) and those who are beneficiaries of the development strategy, the receiving actors are combined.User criterion techniques should be used as a way to assess results in those cases in which the evaluators are users of what is proposed, that is, in addition to having control over the problem being studied, they are "contextualized", immersed in the context in which is the application of the result[7].
The degree of satisfaction-dissatisfaction is a psychological state that manifests itself in people as an expression of the interaction of a set of affective experiences that move between the positive and negative poles insofar as in the activity that the subject develops, the object, responds to their needs and corresponds to their motives and interests[8]. The relationship between indeterminacy and user importance has not yet been clarified and include in Iadov.
Recently a new theory has been introduced in decision making which is known as neutrosophiclogic and set developed by Florentin Smarandache in 1995[9]. The term neutrosophy means knowledge of neutral thought and thisneutral represents the principal distinction between fuzzy and intuitionistic fuzzy logicand sets [10]. With neutrosophy theory, a new logic is introduced in which each proposition is estimated to have a degree of truth (T), adegree of indeterminacy (I) and a degree of falsity (F)[11]. Many extensions of classical decision-making methods have been proposed for dealing with indeterminacy based on neutrosophy theory like DEMATEL [12] AHP [13], VIKOR[14]and TOPSIS [15].
The original proposal of the Iadov method does not allow an adequate management of the indetermination nor the management of the importance of the users[11].The introduction of the neutrosophic estimation seeks to solve the problems of indeterminacy that appear universally in the evaluations of the surveys and other instruments, by taking advantage of not only the opposing positions but also the neutral or ambiguous ones[16]. Under the principle that every idea <A> tends to be neutralized, diminished, balanced by other ideas, in clear rupture with binary doctrines in the explanation and understanding of phenomena[17].
This work continues as follows: Section 2 is about some important concepts about neutrosophy and Iadov . A case study is presented and discussed in section 3. The paper ends with conclusions and some recommendation for future work.

## 2 Materials and methods

In Iadov technique the questionnaire used to determine the degree of user satisfaction with the proposed system of indicators to predict, design and measure the impact of the researcher's strategy has a total of seven questions, three of which are closed and four open, whose relationship is ignored by the subject[18].These three closed questions are related through the "Iadov logical table", which is presented adapted to the present investigation. The resulting number of the interrelation of the three questions indicates the position of each subject in the satisfaction scale, that is, your individual satisfaction This satisfaction scale is expressed by SVN numbers[19]. The original definition of true value in the neutrosophic logic is shown below [20]:
Be $N = \{(T, I, F) : T, I, F \subseteq [0, 1]\}$a neutrosophical valuation is a mapping of a group of proportional formulas to$N$, and for each p sentence we have:

$$v(p) = (T, I, F) \quad (1)$$

In order to ease the practical application to a decision making and engineering problems, it was carried out the proposal of single valued neutrosophic sets (SVNS ) this allows the use of linguistic variables[21, 22], this increase the interpretation of models of recommendation and the usage of the indetermination.

Be $X$ an universe of discourse. A SVNS $A$on $X$is an object of the form.

$$A = \{\langle x, u_A(x), r_A(x), v_A(x)\rangle : x \in X\} \quad (2)$$

where,$u_A(x): X \to [0,1]$, $r_A(x), : X \to [0,1]$and $v_A(x): X \to [0,1]$ with $0 \leq u_A(x) + r_A(x) + v_A(x) : \leq 3$ for all $x \in X$. The intervals $u_A(x), r_A(x)$and $v_A(x)$ denote the memberships to true, indeterminate and false of x in A,

respectively. For convenience reasons, an SVN number will be expressed as$A = (a, b, c)$, where $a, b, c \in [0, 1]$, y a+ $b + c \leq 3$.

In order to analyze the results, it is established a scoring function. To order the alternatives it is used a score function[23]adapted :

$$s(\mathrm{V}) = \mathrm{T} - \mathrm{F} - \mathrm{I} \quad (3)$$

In the event that the assessment corresponds to indeterminacy(not defined) (I) a process of de-neutrosophication developed as proposed by Salmerón and Smarandache[24]. In this case, I ∈ [-1,1].Finally, we work with the average of the extreme values$I \in [0,1]$to obtain a single one.

$$\lambda([a_1, a_2]) = \frac{a_1 + a_2}{2} \quad (4)$$

Subsequently, the results are aggregated and the weighted average aggregation operator is used to calculate the group satisfaction index (GSI). The weighted average (WA) is one of the most mentioned aggregation operators in the literature[25, 26]. A WA operator has associated a vector of weights,$V$, with$v_i \in [0,1]$ and$\sum_1^n v_i = 1$, having the following form:

$$WA(a_1, .., a_n) = \sum_1^n v_i a_i \quad (5)$$

Where $v_i$ represented the importance of the source. This proposal allow to fill a gap in the literature of the Iadov techniques extending it to deal with indeterminacy and importance of user due to expertise or any other reason [27].

## 3 Survey of teachers and methodologists of senior high education:

The case study was developed for the validation of a pedagogical strategy for the development of the competence to undertake as in “10 de Octubre” borough in Havana, CubaA scale with individual satisfaction and its corresponding score value was used (Table 1).

| Expression | Number SVN | Scoring |
|---|---|---|
| Clearly pleased | (1, 0, 0) | 1 |
| More pleased than unpleased | (1, 0.25, 0.25) | 0.5 |
| Not defined | I | 0 |
| More unpleased than pleased | (0.25, 0.25, 1) | -0.5 |
| Clearly unpleased | (0,0,1) | -1 |
| Contradictory | (1,0,1) | 0 |

Table 1. Individual satisfaction scale.

A sample of 21 teachers and methodologists from senior high education were surveyed. The survey was elaborated with 7 questions, three closed questions interspersed in four open questions; of which 1 fulfilled the introductory function and three functioned as reaffirmation and sustenance of objectivity to the respondent.

| | Would you consider postponing the development of the competence to undertake as a contribution to the comprehensive education of the student of senior high education? | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No | | | I don´t know | | | yes | | |
| Do your expectations meet the application of the strategy for the development of the competence to undertake as a contribution to the comprehensive education of the student of senior high education? | If you could choose freely, a strategy for the formation of competencies in students of senior high education would you choose one with similar characteristics to the one used for the development of the competence to undertake? | | | | | | | | |
| | yes | I don´t know | No | yes | I don´t know | No | yes | I don´t know | No |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Very pleased. | 1 (14) | 2 (2) | 6 | 2 | 2 | 6 | 6 | 6 | 6 |
| Parcially pleased. | 2 (2) | 2 (2) | 3 | 2 (1) | 3 | 3 | 6 | 3 | 6 |
| It's all the same to me | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| More unpleased than pleased. | 6 | 3 | 6 | 3 | 4 | 4 | 3 | 4 | 4 |
| Not pleased | 6 | 6 | 6 | 6 | 4 | 4 | 6 | 4 | 5 |
| I don´t know what to say | 2 | 3 | 6 | 3 | 3 | 3 | 6 | 3 | 4 |

Table 2. The logical picture of the Iadov technique for teachers and methodologists from senior high education.

In this case,the following results are as follows:

| Expression | Total | % |
|---|---|---|
| Clearly pleased | 14 | 66 |
| More pleased than unpleased | 7 | 33 |
| Not defined | 0 | 0 |
| More unpleased than pleased | 0 | 0 |
| Clearly unpleased | 0 | 0 |
| Contradictory | 0 | 0 |

Table 3.Results of the application to teachers and methodologists.

The calculation of the score is carried out and it is determined by I. in this case, it was given the same value to each user. The final result of the index of group satisfaction (GSI) that the method portrays, in this case, is: GSI =0.82

This shows a high level of satisfaction according to the satisfaction scale.

For the students, a survey similar to that of the teachers was prepared, and a total of 101 senior high students were interviewed who received the training program with the following results:

| | Can you do without undertaking and achieve your professional realization? | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No | | | I don´t know | | | yes | | |
| Are you satisfied with the way in which the program was applied to develop your skills and knowledge to learn to undertake? | Would you like to be an entrepreneur and take on the challenges in your future personal performance? | | | | | | | | |
| | yes | I don´t know | No | yes | I don´t know | No | yes | I don´t know | No |
| Very pleased. | 1 (71) | 2 (2) | 6 | 2 | 2 | 6 | 6 | 6 | 6 |
| Parcially pleased. | 2 (23) | 2 (1) | 3 | 2 (1) | 3 | 3 | 6 | 3 (1) | 6 |
| Its all the same to me. | 3 (1) | 3 | 3 | 3 | 3 (1) | 3 | 3 | 3 | 3 |
| more unpleased than pleased. | 6 | 3 | 6 | 3 (1) | 4 | 4 | 3 | 4 | 4 |
| Not pleased | 6 | 6 | 6 | 6 | 4 | 4 | 6 | 4 | 5 |
| I don´t know what to say | 2 | 3 | 6 | 3 | 3 | 3 | 6 | 3 | 4 |

**Table 4.**Logical picture of Iadov students of senior high education.

In this case, the following results are obtained:

| Expression | Total | % |
|---|---|---|
| Clearly pleased | 71 | 70.3 |
| More pleased than unpleased | 27 | 26.7 |
| Not defined | 3 | 2.97 |
| More unpleased than pleased | 0 | 0 |
| Clearly unpleased | 0 | 0 |
| Contradictory | 0 | 0 |

Table 5.Results of the application of the students in senior high.

The calculation of the score is carried out. In this case, it was given the same value of importance to each user. The final result of the index of group satisfaction (GSI) that the method portrays, in this case, is: GSI=0.837 this shows a high level of satisfaction according to the satisfaction scale.

By locating the values reached in the satisfaction scale

- Actors developers: 0.809
- Recipients – actors: 0.837

In both cases, the results are positive, which certifies the effectiveness of the implementation of the strategy, as shown in the graph.

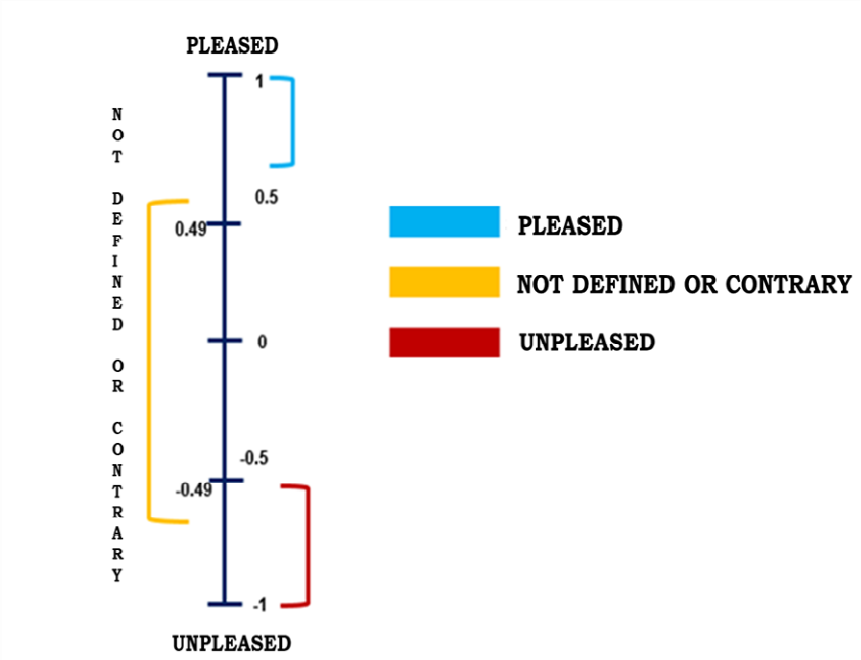


Figure 1. Scale with group satisfaction index

The proposal of extending Iadov method with neutrosophyresults to be easy to use and practical in real-world application. The inclusions of indeterminacy allow a more powerful way to represent information compared with the classical application of the technique. The inclusion of the aggregation operator extends the traditionalIadov method including the importanceof information sources[28]. The application in the real world of the proposal validates the pedagogical strategy for the formation of the competence entrepreneurship in high education.

## Conclusions

In this paper, the Iadov method was extended allowing an adequate management of the indeterminacy and the management of the importance of users. Iadov's method with the inclusion of neutrosophic analysis showed its applicability and ease of use in a case study. Among the advantages with respect to the original approach is that it can incorporate the indetermination and contradiction more naturally. Another advantage is that it allows the use of aggregation operators which makes it possible to express, in this case, the importance or expertise of users according to experience or some other criteria.

The validation process using the neutrosophic Iadov technique in users of the implementation of the pedagogical strategy for the formation of the competence entrepreneurship in high education in “10 de Octubre” borough in Havana, Cuba confirmed its feasibility of use. The results were expressed quantitatively in a high Group Satisfaction Index in the two applications presented in the case study.

Future works will concentrate on the uses of the 2-tuplelinguistic model for giving a linguistic output and the use of different aggregation operator. The development of a software tool supporting the proposal is another area of future research.

## References


1. Batista Hernández, N., N. Valcárcel Izquierdo, G. Real Zumba, and A.D. Albán Navarro, *Desarrollo de la competencia de emprendimiento; unanecesidad en la formación integral del estudiante.*Dilemas Contemporáneos: Educación, Política y Valores, 2017. **5**(1).
2. Henríquez Antepara, E.J., A. Arzube, O. Omar, C. Arroyave, J. Arturo, E.A. Alvarado Unamuno, and M. Leyva Vazquez, *Competencies evaluation based on single valued neutrosophic numbers and decision analysis schema.* Neutrosophic Sets & Systems, 2017. **17**: p. 16-19.
3. Hernández, N.B., W.O. Aguilar, and J.E. Ricardo, *El desarrollo local y la formación de la competencia pedagógica de emprendimiento. Una necesidad en el contexto social de Cuba.* Revista Didasc@ lia: Didáctica y Educación. ISSN 2224-2643, 2017. **8**(5): p. 213-226.
4. López, A. and V. González, *La técnica de Iadov. Una aplicación para el estudio de la satisfacción de losalumnospor las clases de educación física.* Revista Digital [internet] Abril, 2002. **47**: p. 202.
5. Kuzmina, N., *Metódicas investigativas de la actividad pedagógica.* Editorial Leningrado, 1970.
6. Pablo-Lerchundi, I., M.-C. Núñez-del-Río, and R.-M. González-Tirados, *Career choice in engineering students: its relationship with motivation, satisfaction and the development of professional plans.* Anales de Psicología/Annals of Psychology, 2015. **31**(1): p. 268-279.
7. Flores, I.G. and V.M. Miguel, *A contribution to the management of information science, technology and innovation.* Vivat Academia, 2017. **20**(140): p. 55-63.
8. Fernández de Castro Fabre, A. and A. López Padrón, *Validación mediantecriterio de usuarios del sistema de indicadores para prever, diseñar y medir el impacto en losproyectos de investigación del sector agropecuario.* Revista Ciencias Técnicas Agropecuarias, 2014. **23**(3): p. 77-82.
9. Biswas, P., S. Pramanik, and B.C. Giri, *Neutrosophic TOPSIS with Group Decision Making*, C. Kahraman and İ. Otay, Editors. in *Fuzzy Multi-criteria Decision-Making Using Neutrosophic Sets (pp. 543-585), (*2019), Springer International Publishing: Cham.doi. https://doi.org/10.1007/978-3-030-00045-5_21.
10. Smarandache, F. and S. Pramanik, *New Trends in Neutrosophic Theory and Applications; Pons Editions: Brussels, Belgium, 2016*. ISBN 978-1-59973-498-9
11. Maikel Leyva Vázquez, F.S., *Neutrosofía: Nuevos avances en el tratamiento de la incertidumbre*. 2018: Pons Publishing House / Pons asbl.
12. Abdel-Basset, M., G. Manogaran, A. Gamal, and F. Smarandache, *A hybrid approach of neutrosophic sets and DEMATEL method for developing supplier selection criteria.* Design Automation for Embedded Systems, 2018: p. 1-22.
13. Abdel-Basset, M., M. Mohamed, Y. Zhou, and I. Hezam, *Multi-criteria group decision making based on neutrosophic analytic hierarchy process.* Journal of Intelligent & Fuzzy Systems, 2017. **33**(6): p. 4055-4066.
14. Abdel-Basset, M., Y. Zhou, M. Mohamed, and V. Chang, *A group decision making framework based on neutrosophic VIKOR approach for e-government website evaluation.* Journal of Intelligent & Fuzzy Systems, 2018. **34**(6): p. 4213-4224.
15. Biswas, P., S. Pramanik, and B.C. Giri, *TOPSIS Strategy for Multi-Attribute Decision Making with Trapezoidal Neutrosophic Numbers.* Neutrosophic Sets and Systems, 2018. **19**: p. 29-39.
16. Smarandache, F., *A Unifying Field in Logics: Neutrosophic Logic. Neutrosophy, Neutrosophic Set, Neutrosophic Probability: Neutrosophic Logic: Neutrosophy, Neutrosophic Set, Neutrosophic Probability*. Third ed. 2003: American Research Press.
17. Smarandache, F., *Law of Included Multiple-Middle & Principle of Dynamic Neutrosophic Opposition*. 2014, Belgium: EuropaNova.
18. Leyva-Vázquez, M., *Modelo de Ayuda a la Toma de Decisiones Basado en Mapas Cognitivos Difusos. 2013, UCI.* Doctor en Ciencias Técnicas: La Habana, 2018.
19. Smarandache, F. and M. Leyva-Vázquez, *Fundamentos de la lógica y los conjuntos neutrosóficos y supapel en la inteligencia artificial.* Neutrosophic Computing and Machine Learning, 2018(1).
20. Wang, H., F. Smarandache, R. Sunderraman, and Y.Q. Zhang, *Interval Neutrosophic Sets and Logic: Theory and Applications in Computing: Theory and Applications in Computing*. 2005: Hexis.
21. Vázquez, M.Y.L., K.Y.P. Teurel, A.F. Estrada, and J.G. González, *Modelo para el análisis de escenariosbasados en mapascognitivosdifusos: estudio de caso en software biomédico.* Ingenieria y Universidad: Engineering for Development, 2013. **17**(2): p. 375-390.
22. Broumi, S., J. Ye, and F. Smarandache, *An Extended TOPSIS Method for Multiple Attribute Decision Making based on Interval Neutrosophic Uncertain Linguistic Variables.* Neutrosophic Sets & Systems, 2015. **8**: p. 22-30.

23. Wang, J.-q., Y. Yang, and L. Li, *Multi-criteria decision-making method based on single-valued neutrosophic linguistic Maclaurin symmetric mean operators.* Neural Computing and Applications, 2018. **30**(5): p. 1529-1547.
24. Salmerona, J.L. and F. Smarandacheb, *Redesigning Decision Matrix Method with an indeterminacy-based inference process.* Multispace and Multistructure. Neutrosophic Transdisciplinarity (100 Collected Papers of Sciences), 2010. **4**: p. 151.
25. Said, B. and F. Smarandache, *Multi-attribute decision making based on interval neutrosophic trapezoid linguistic aggregation operators*. in *Handbook of Research on Generalized and Hybrid Set Structures and Applications for Soft Computing (pp. 344-365), (*2016), IGI Global
26. Yu, D., *A scientometrics review on aggregation operator research.* Scientometrics, 2015. **105**(1): p. 115-133.
27. Biswas, P., S. Pramanik, and B.C. Giri, *TOPSIS method for multi-attribute group decision-making under single-valued neutrosophic environment.* Neural computing and Applications, 2016. **27**(3): p. 727-737.
28. Pramanik, S., P.P. Dey, B.C. Giri, and F. Smarandache, *An extended TOPSIS for multi-attribute decision making problems with neutrosophic cubic information.* Neutrosophic Sets & Systems, 2017. **17**: p. 20-28.

Received: October 22, 2018. Accepted: November 19, 2018