MENDIVE
REVISTA DE EDUCACIÓN

Original article

Skills related to the operationalization of variables in university curricular research

Habilidades relacionadas con la operacionalización de variables en la investigación curricular universitaria

Habilidades relacionadas à operacionalização de variáveis na pesquisa de currículo universitário

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Received: July 18, 2024
Accepted: November 19, 2024

ABSTRACT

The methodology of scientific research constitutes one of the pillars of university teaching, in the formulation of technical solutions to various scientific and professional problems. The identification and operationalization of variables is one of the guiding threads of the research process, and the development of skills for this purpose is vital. The objective of the work was to carry out an analysis of the improvement of research skills related to the operationalization of variables in students of the Pedagogy of National and Foreign Languages and Pedagogy of Experimental Sciences, Computer Science careers of the Faculty of Philosophy, Letters and Education Sciences at the Central University of Ecuador, during the second academic period of the year 2023. A mixed research with a transversal design was developed, using theoretical methods such as historical and systemic and empirical methods such as: observation, through a questionnaire; measurement with non-parametric descriptive and inferential statistics; and a quasi-experiment with the application during the academic period, of a program in which the content of variables was considered as a guiding and integrating axis of the rest of the content. The measurement carried out before the application of the program (pretest) indicated average levels in all the parameters considered in the questionnaire, which improved in the posttest, with significant differences in most based on the Wilcoxon signed rank test. The management of the variables as a guiding and integrating axis of the teaching of the subject of Scientific Research Methodology was positive in the group of selected students.

Keywords: skills; research; curriculum research; operationalization; university; variables.

RESUMEN

La metodología de la investigación científica constituye uno de los pilares de la enseñanza universitaria, en el planteamiento de soluciones técnicas a los diversos problemas científicos y profesionales. La identificación y operacionalización de variables es uno de los hilos conductores del proceso de investigación, siendo vital el desarrollo de habilidades al efecto. El objetivo del trabajo fue realizar un análisis de la mejora de habilidades de investigación relacionadas con la operacionalización de variables en estudiantes de las carreras de Pedagogía de Idiomas Nacionales y Extranjeros y Pedagogía de las Ciencias Experimentales, Informática de la Facultad de Filosofía, Letras y Ciencias de la Educación en la Universidad Central del Ecuador, durante el segundo periodo académico del año 2023. Se desarrolló una investigación mixta con un diseño transversal, empleando métodos teóricos como el histórico y sistémico y empíricos como: la observación, a través de un cuestionario; la medición con estadística descriptiva e inferencial no paramétrica; y un cuasi experimento con la aplicación durante el periodo académico, de un programa en el que se consideró el contenido de variables como eje conductor e integrador del resto de contenidos. La medición realizada antes de la aplicación del programa (pretest) indicó niveles medios en todos los parámetros considerados en el cuestionario, los cuales mejoraron en el postest, con diferencias significativas en la mayoría con base a la prueba de rangos con signo de Wilcoxon. El manejo de las variables como eje conductor e integrador de la enseñanza de la asignatura de Metodología de la Investigación Científica resultó positivo en el grupo de estudiantes seleccionados.

Palabras clave: habilidades; investigación; investigación curricular; operacionalización; universidad; variables.

RESUMO

A metodologia da pesquisa científica é um dos pilares da formação universitária, na abordagem de soluções técnicas para diversos problemas científicos e profissionais. A identificação e a operacionalização de variáveis é um dos principais fios condutores do processo de pesquisa, e o desenvolvimento de habilidades para esse fim é vital. O objetivo deste estudo foi analisar o aprimoramento das habilidades de pesquisa relacionadas à operacionalização de variáveis em alunos da Faculdade de Filosofia, Letras e Ciências da Educação da Universidade Central do Equador, durante o segundo período acadêmico do ano de 2023. Foi desenvolvida uma pesquisa mista com um desenho transversal, utilizando métodos teóricos como o histórico e o sistêmico e métodos empíricos como: observação, por meio de um questionário; medição com estatística descritiva e inferencial não paramétrica; e um quase-experimento com a aplicação, durante o período acadêmico, de um programa no qual o conteúdo das variáveis foi considerado como o eixo principal e integrador do restante do conteúdo. A medição realizada antes da aplicação do programa (pré-teste) indicou níveis médios em todos os parâmetros considerados no questionário, que melhoraram no pós-teste, com diferenças significativas na maioria deles com base no teste de Wilcoxon. A gestão das variáveis como eixo condutor e integrador do ensino da disciplina de Metodologia da Pesquisa Científica foi positiva no grupo de alunos selecionados.

Palavras-chave: habilidades; pesquisa; pesquisa curricular; operacionalização; universidade; variáveis.

INTRODUCTION

In the international university world, the subject Scientific Research Methodology (SRM) is generally an invariant in the curricular grids of undergraduate programs, regardless of the area of science; this, understanding that one of the fundamental skills for any professional is to solve problems of a technical and/or scientific nature, for which the methodology of each science provides valuable tools. It is not the objective of this work to justify the importance of SRM at the university level of training, but it is important to contextualize this research in this area. According to Toala-Toala and Mendoza (2019), the teaching of this subject also allows universities to fulfill their social role of generating science, technology and innovation, with the participation of students and teachers.

In this sense, it should be noted that unlike other subjects in the curriculum, MIC takes on a transversal character, since it is applied throughout the development of the study program with a curricular character, and also in the extracurricular research activities that the student develops by his or her own will and motivation.

Despite the efforts of educational institutions and students themselves, in many cases the achievement of significant levels of improvement in the acquisition of research skills through MIC or other subjects and curricular activities is not as expected. In the case of the work presented by Clavijo *et al.* (2017), despite the high valuation shown by students for their research activities, no significant changes were evident in skills such as teamwork, analysis and problem solving, creativity, synthesis and writing of reports, use of the Internet, systematization of content, among others.

Within the broad field of content handled in the MIC subject, this work focuses on one of the most complex and important constructs: research variables, which are defined by Hernández Sampieri *et al.* (2020) as the "Property that has a variation that can be measured or observed" (p. 93). According to these authors, "variables acquire value for scientific research when they become related to other variables, that is, if they are part of a hypothesis or a theory. In this case, they are often called constructs or hypothetical constructions" (p. 93).

The strategic importance of variables for research and the study of MIC lies in the above: its "linking" character between theory and the measurement/intervention to which the research will be subject.

According to Rodríguez *et al.* (2021), variables constitute the transversal axis of the research, since they arise at the moment of identifying the idea to be investigated and their manipulation is in force throughout the entire process. According to these authors, the most general classification of variables is the one that identifies them based on their level of causality, by their nature and by their measurement value; which is key to their operationalization, recognized as the phase of conceptual definition of the variable, identification of its dimensions, indicators and measurement methods (Espinoza, 2019). Thus, the operationalization of variables must be developed after the design of the theoretical, conceptual and referential framework of the research; the latter being the one that will also allow the second stage of operationalization to be completed, through the identification or not of instruments that allow measuring the variables identified in the research.

The development of skills related to the operationalization of variables, that is, their identification, definition and proposal for measurement, is essential for university students, both for the MIC subject and for their future curricular and extracurricular research development. The acquisition of these skills is influenced by multiple factors, such as the preparation and research experience of the professors and the prior conceptual and technical knowledge of the students, the availability of updated documentary information, among others.

There are many books, manuals and research aimed specifically at improving knowledge and skills related to this topic, with a methodological approach, in general, which, as Arias González (2021) indicates, is of great importance, both theoretically and practically, for students and researchers.

However, one of the fundamental factors is the application of appropriate didactic strategies for the teaching-learning of this content, as part of the MIC subject. Therefore, in the present work, the improvement of research skills related to the operationalization of variables in students of the majors of Pedagogy of National and Foreign Languages and Pedagogy of Experimental Sciences, Computer Science of the Faculty of Philosophy, Letters and Education Sciences at the Central University of Ecuador, during the second academic period of the year 2023, was analyzed. The above, as a basis for the implementation of improvements in the didactics of the MIC subject.

MATERIALS AND METHODS

A mixed cross-sectional design research was developed, using theoretical methods such as: historical, dialectical and systemic; while, from the empirical point of view, scientific observation and measurement were used.

The observation instrument consisted of a 12-question questionnaire, developed by the authors and validated by seven experts, for which the Cronbach Alpha statistic was applied.

A quasi-experiment was developed with the evaluation, at the beginning of the academic period, of 31 students of the Pedagogy of National and Foreign Languages and Pedagogy of Experimental Sciences, Computer Science of the Faculty of Philosophy at the Central University of Ecuador, who received the MIC subject; at the end of the study period, after the application of a program of activities, which, with a constructivist approach, allowed the participation of students in learning the subject related to the research variables.

The program was applied for 13 weeks and was based on the use of the concept of variables as the guiding and integrating axis of the research process, from the initial phases of identifying the idea and research problem, to the stages of setting out the methodology (data collection and analysis). In the same way, specific activities were developed in the classes to address and delve deeper into this specific content and its link with other contents of the subject. The program was validated following the same methodology indicated above.

During the investigation, ethical considerations for this type of research were handled.

Measurement was performed using descriptive statistics (mean and standard deviation) and non-parametric inferential statistics (Wilcoxon signed rank test) to assess whether there was a significant difference between the posttest and the pretest ($p \leq 0.05$). Microsoft Excel was used to tabulate data and SPSS V25 was used to calculate descriptive statistics and the selected non-parametric test.

RESULTS

As mentioned above, the validation of the questionnaire applied was carried out by experts, obtaining a Cronbach's Alpha value of 0.92, which indicates that it is consistent for its application, based on the proposed objective. Likewise, the validation of the program yielded a Cronbach's Alpha value of 0.87.

Table 1 shows the descriptive result of the aspects contained in the survey, based on the mean and standard deviation statistics.

Table 1- Parameters evaluated in the questionnaire (pretest and posttest)

Parameter	Pretest		Posttest	
	Average	Standard deviation	Average	Standard deviation
Importance of variables for an investigation	3.9	1.07	4.2	.93
Importance of teacher experience in teaching MIC	3.7	1.15	4.1	.89
Knowledge of the different classifications of variables	3.1	1.07	3.9	.94
Level of knowledge to operationalize variables in an investigation	3.2	1.05	3.8	.87
Skill level and practice to operationalize variables in an investigation	3.2	1.02	3.9	.92
Skill level to identify variables when defining the research idea	3.6	1.08	4.3	.77
Support of the theoretical, conceptual and referential framework to operationalize variables	3.7	1.01	4.4	.66
Level of achievement in the conceptualization of variables	3.6	.97	3.8	.84
Skill level for identifying quality bibliographic sources and managing information for conceptualizing variables	3.7	1.00	4.1	.77
Level of achievement in identifying useful indicators to measure the variables	3.5	1.07	3.9	.84
Level of achievement in identifying useful methods and instruments for measuring variables	3.2	1.12	4.1	.96
Level of knowledge and skills in statistics for the measurement of variables	3.6	1.05	4.3	.59
General behavior	**3.5**	**1.07**	**4.1**	**.91**

Source: Prepared by the authors based on statistical analysis

As can be seen, in the pretest, the values of the 12 questions included in the questionnaire oscillated at a medium level (3.5 as a general average), with standard deviation levels close to or greater than 1 (1.07 in general); which indicates that the development of research skills related to the operationalization of variables in students of the majors of Pedagogy of National and Foreign Languages and Pedagogy of Experimental Sciences, Computer Science of the Faculty of Philosophy, Letters and Educational Sciences at the Central University of Ecuador during the second academic period of the year 2023 is not the desired one.

After the implementation of the activities program during the academic period, the questionnaire was applied again, in which the improvement in the 12 parameters evaluated was evident, all reaching values higher than the pretest (4.1 on average), seven of them with scores higher than 4 and with a standard deviation less than 1 in all cases (.91 in general).

In order to determine the existence of significant differences between the posttest and the pretest, the Wilcoxon signed rank test was applied, the results being shown in table 2.

Table 2- Wilcoxon signed rank test

Parameter	Level of significance
Importance of variables for an investigation	1,000
Importance of teacher experience in teaching MIC	.083
Knowledge of the different classifications of variables	.003
Level of knowledge to operationalize variables in an investigation	.010
Skill level and practice to operationalize variables in an investigation	.006
Skill level to identify variables when defining the research idea	.006
Support of the theoretical, conceptual and referential framework to operationalize variables	.010
Level of achievement in the conceptualization of variables	.317
Skill level for identifying quality bibliographic sources and managing information for conceptualizing variables	.038
Level of achievement in identifying useful indicators to measure the variables	.083
Level of achievement in identifying useful methods and instruments for measuring variables	.003
Level of knowledge and skills in statistics for the measurement of variables	.011

Source: Own elaboration based on statistical analysis

According to the test applied, in all questions of the questionnaire, except 1, 2, 8 and 10, the existence of significant differences between the post-test and the pre-test was determined, showing the validity of the program applied in general.

DISCUSSION

The situation evidenced in the research coincided with studies at an international level that indicate that the general level of learning of university students in the different stages of the research methodology process is not the desired one. For example, Díaz *et al.* (2020) indicate that although students have a predisposition to develop research in the IT field, the lack of prior knowledge, the loss of time and the excessive consumption of digital resources outside the degree, limit the results in the MIC subject. Added to this is that, on many occasions, despite the fact that the study programs consider both curricular or formative research, as well as extracurricular research, this is limited to specific end-of-subject works and degree or final degree works (León *et al.*, 2023); the above is due, in many cases, to the lack of management from the macro, meso and micro-curriculum of the research process, in the field of university educational models (Velázquez *et al.*, 2020).

In this regard, according to González *et al.* (2020), the development of the investigative spirit of students is essential, together with the process of planning training activities, which tends to solve problems, from the appropriation and implementation of research processes duly conducted by university teachers and researchers. In particular, the low level of development of skills related to the knowledge of variable classifications, their operationalization and the identification of useful methods and instruments to measure the variables stood out in the research. All this reinforced the nature of the program to be implemented during the academic period, based on considering the content of the variables as an integrating axis of the rest of the contents of the MIC subject. The mastery of research methods, both theoretical and empirical, is a specific need for each area of science, to which much interest must be paid in the teaching of MIC, from effective pedagogical perspectives such as constructivism, connectivism and neurolearning (Velázquez *et al.*, 2020).

Despite the improvement seen after the implementation of the activities program, the students' perception of the development of their skills in the stages of conceptualization and operationalization of variables remained at medium levels, indicating the need to delve deeper into aspects related to the analysis of the theory associated with the research topic; with emphasis on the construction of theoretical, conceptual and referential frameworks, which

constitute the general scope for conceptualizing and operationalizing variables.

For instance, as Hernández Sampieri *et al. (2020)* recognize, the presence of "pieces and chunks of theory with some empirical support, which suggest potentially important variables and which apply to our research problem (they can be empirical generalizations and hypotheses supported by some studies)" (p. 59) is one of the functions in the design of the theoretical framework that is most highlighted in the literature. In this regard, he highlighted that the recognition of the importance of the theoretical, conceptual and referential framework to operationalize variables, by the students, was the parameter studied that showed the most improvement between the posttest and the pretest; which is positive in the face of the need to take advantage of these contents to improve the development of skills related to working with research variables.

In the operationalization phase, it is also very important to recognize the techniques to be used in measurement (both qualitative and quantitative), with the use of statistics being one of the most commonly used. The study showed that, after the MIC course, the level of skills in this regard improved. This stage in the research is crucial to reduce the deficiencies associated with high subjectivity, theoretical-empirical inconsistencies and lack of credibility and reliability in the results. In relation to subjectivity, it is one of the aspects that must be handled most in research, especially in the social and human sphere (Brown, 2019).

Specifically, the prior acquisition of statistical skills is key to the work of the university student in the MIC subject. In this sense, Charalambous *et al.* (2021) report that teamwork, control of student anxiety and previous academic performance are some of the factors that most influence the improvement of these skills, without which the operationalization phase of variables is complicated, due to the need for the student to master the spectrum of techniques that can be applied, both in qualitative, quantitative or mixed-approach research.

The application of the Wilcoxon signed rank test allowed to show the significant change in most of the parameters considered in the study, except for the recognition of the level of importance of the variables in the research and the importance of the teacher's experience in teaching Scientific Research Methodology; both questions being auxiliary in the instrument, and which were not directed to evaluate self-perception in the development of specific skills.

The importance of teaching experience, emotional control (especially insecurity), pedagogical preparation and interest in research are some of the factors that, according to García-Carmona and Toma (2024), most influence the effectiveness of research education.

Of the skills evaluated, there were also no significant changes in the level of achievement in the conceptualization of variables and in the identification of useful indicators to measure the variables; aspects that should be prioritized in future pedagogical interventions for the groups considered in the study, due to insufficient manifestations in practice.

The application of the program in the teaching of the MIC subject in the selected course allowed to achieve improvements in important aspects such as the mastery of the different classifications of variables, their identification when defining the research idea, their conceptualization and operationalization, the usefulness of the theoretical, conceptual and referential frameworks, the identification of quality bibliographic sources and management of information, methods and instruments to measure the variables and the use of statistics. All this was achieved, considering that the program contained activities focused on the identification of variables and their management, from the initial stage of the methodology (statement of the idea and research problem).

Likewise, in the design and execution of the program, special consideration was given to the use of technological tools to support teaching, such as the Internet, Artificial Intelligence, computer programs, among other resources, as they are useful in adapting teaching to the characteristics of university students and preparing them to acquire skills that facilitate their future professional performance (Regueira *et al.*, 2018).

The use of this type of programs, with a constructivist approach, tends to achieve significant learning in MIC, and in turn affects the mastery of other subjects in the degrees, as Balletbo and Balletbo (2022) point out; this generates a systemic and integrative effect of the MIC subject at the university level. Precisely, the integrative approach of the MIC subject implies that, on the one hand, prior knowledge of the different objects of study associated with the scientific discipline or related science is required; on the other hand, there is a high incidence in the expansion of the level of knowledge and skills in relation to these objects, due to the ability that the student acquires to delve into theories, models, concepts and other epistemological structures, which will expand their possibility of solving professional problems effectively.

The topic addressed in the study is not sufficiently covered in previous research, which is why it is interesting to address and delve deeper into it in future work. The management of research variables is considered the guiding and integrating axis of teaching the MIC subject, and its study in the selected group of students is useful, as it shows the improvement in the perception of the level of development of the skills related to the management of variables, except for the achievement in the conceptualization and in the identification of useful indicators to measure them.

It is necessary to promote future research related to the topic addressed in this work, since continuous improvement in the teaching of MIC is key in universities that aspire to develop research processes that involve students, both in the formative and extracurricular fields.

BIBLIOGRAPHIC REFERENCES

Arias González, J. (2021). Guía para elaborar la operacionalización de variables. *Espacio I+D: Innovación más Desarrollo, 10*(28), 42-56. https://doi.org/10.31644/IMASD.28.2021.a02

Balletbo, I., y Balletbo, J. (2022). Relación de la investigación científica con la construcción de aprendizajes significativos de la carrera de Administración de Empresas. *ScienteAmericana, 9*(2), 123-134. https://doi.org/10.30545/scientiamericana.2022.jul-dic.4

Brown, S. (2019). Subjectivity in the Human Sciences. *Psychological Record, 69*(4), 565-579. https://doi.org/10.1007/s40732-019-00354-5

Charalambous, M., Hodge, J., y Ippolito, K. (2021). Statistically significant learning experiences: towards building self-efficacy of undergraduate statistics learners through team-based learning. *Educational Action Research, 29*(2), 226-244. https://doi.org/10.1080/09650792.2020.1782240

Clavijo, W., Delgado, A., Parra, H., Fernández, A., y Chicaiza, O. (2017). Percepción estudiantil sobre habilidades de investigación en la Universidad de las Fuerzas Armadas ESPE. *Lecturas: Educación Física y Deportes (EFDeportes.com), 22*(232), 1-12. https://www.efdeportes.com/efd232/percepcion-estudiantil-sobre-investigacion-en-espe.htm

Díaz, T., Paredes, I., Bolaño, Y., y Machado, R. (2020). Diagnóstico inicial en la impartición de la asignatura Metodología de la investigación. Estudio de caso. *Serie Científica de la Universidad de las Ciencias Informáticas, 13*(10), 1-12. https://publicaciones.uci.cu/index.php/serie/article/view/638

Espinoza, E. (2019). Las variables y su operacionalización en la investigación educativa. Segunda parte. *Conrado, 15*(69), 171-180. https://conrado.ucf.edu.cu/index.php/conrado/article/view/1052

García-Carmona, A., y Toma, B. (2024). Integration of Engineering Practices into Secondary Science Education: Teacher Experiences, Emotions, and Appraisals. *Research in Science Education, 54*(4), 549-572. https://doi.org/10.1007/s11165-023-10152-3

González, M., Marín, L., y Fernández, A. (2020). La formación del espíritu investigativo en los estudiantes universitarios. *Efdeportes. Lecturas: Educación Física y Deportes, 25*(268), 1-7. https://www.efdeportes.com/efdeportes/index.php/EFDeportes/article/view/2420/1282

Hernández Sampieri, R., Fernández, C., y Baptista, P. (2020). *Metodología de la Investigación.* Mc Graw Hill.

León, R., Hernández, A., y González, S. (2023). El trabajo investigativo de los estudiantes en el proceso de enseñanza aprendizaje de la Matemática. *Revista Cubana de Educación Superior, 42*(3), 37-51. https://revistas.uh.cu/rces/article/view/8489

Regueira, D., Calzada, D., y Fernández, A. (2018). La formación docente del estudiante universitario para que aprenda a enseñar. Una propuesta innovadora. En J. Almuiñas, J. Galarza, y J. López, *La innovación en la gestión universitaria (Experiencias y alternativas para su desarrollo)* (págs. 277-295). RED-DEES.

Rodríguez, C., Breña, J., y Esenarro, D. (2021). *Las variables en la Metodología de la Investigación Científica.* Editorial Área de Innovación y Desarrollo, S.L. https://doi.org/10.17993/IngyTec.2021.78

Toala-Toala, G., y Mendoza, A. (2019). Importancia de la enseñanza de la metodología de la investigación científica en las ciencias administrativas. *Dominio de las Ciencias, 5*(2), 56-70. https://doi.org/10.23857/dom.cien.pocaip.2019.5.2.abril.56-43

Velázquez, M., Amat, M., y Mena, M. (2020). La epistemología y la metodología de la investigación en la carrera de Derecho. *CONRADO. Revista pedagógica de la Universidad de Cienfuegos, 16*(SI), 95-102. https://conrado.ucf.edu.cu/index.php/conrado/article/view/1527/1511

Conflict of interests:

The authors declare not to have any interest conflicts.

Authors' contribution:

The authors participated in the design and writing of the article, in the search and analysis of the information contained in the consulted bibliography.

Cite as

Chumaña Suquillo, J. V., Taramuel Villacreces, T. A., Prado Yépez, L. E. (2024). Skills related to the operationalization of variables in university curricular research. *Mendive. Journal on Education*, *22*(4), e3945. https://mendive.upr.edu.cu/index.php/MendiveUPR/article/view/3945