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An Example Of Abet Competencies For Programming Fundamentals At Ufpso University

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Abstract

This research focuses on the ABET competencies and their implementation for the Systems Engineering program and the Fundamentals of Programming microcurriculum of the University Francisco de Paula Santander Ocaña (UFPSO) in Colombia, where the learning outcomes, the competency matrix, the evaluation rubric, as well as the different activities to evaluate the results are described. The competencies analyzed are the identification and resolution of problems using engineering and the ability to communicate with different audiences. Two groups composed of 19 and 16 students are used, which are evaluated through a final exam, meeting an average per competency over 4.0, achieving satisfactory for the beginning of the competencies and the subsequent improvement of the learning outcomes. The systems engineering program aims to achieve that its subjects have the ABET competencies and thus be accredited internationally.

Keywords: ABET, international accreditation, programming fundamentals, Engineering, educational competencies.

1. Introduction

Higher education worldwide presents high levels of quality, which means that all universities must incorporate processes that allow them to improve their educational programs. That is why the accreditation model of the international agency Accreditation Board of Engineering and Technology (ABET) allows knowing when a program meets the quality criteria established for a specific program (ACOFI, 2022). There are more than 895 accredited institutions in 40 countries, where programs in applied science, computer science, engineering and technology are found. In Colombia, high quality accreditation is voluntary and supervised by the National Accreditation Council (CNA), as a state body, while in the United States it is carried out by non-governmental entities such as ABET, which allows programs accredited in Colombia and through ABET to comply with an international quality standard (ABET, 2022; ACOFI, 2022).

The accreditation models of the programs should be similar to the ABET requirements, that is why examples of models are created in different parts of the world as in the United Arab Emirates (UAE), where testing is performed for the mechanical engineering program mecánica (Elnajjar et al., 2019), where the benefits for students can be in the design of courses, in the measurement and evaluation of learning outcomes, identifying strengths and weaknesses. Processes in careers such as civil engineering are based on accrediting not only old programs, but also creating a framework for accreditation of new programs, where each program needs to establish and achieve its own objectives, by assessing the learning outcomes acquired as knowledge, behaviors and skills of students (Iqbal Khan et al., 2016).

Analyzing software programs can be measured by the performance of quizzes, projects, final exams, and laboratories, among others but also directly by the teacher's attendance reports and their academic evaluation, as well as the students' qualification, allowing continuous improvement (Rashideh et al., 2020). It is also a way to measure the labor supply that graduates of universities may have in their computer science specialties since in this way it establishes the generic requirements that each educational program must have (Zaid Abualkishik et al., 2022).

Universities compete to improve their performance, and it is also a way to compare the level of education locally and internationally, as is done in the research of the Kingdom of Saudi Arabia, which compares the universities in the country, in addition to an extensive categorization of Asia and the Arab region (Faiz & Almutairi, 2021). Sometimes accreditation comparisons are made with local methodologies and Abet, so that the local methodology is under the highest quality standards in order to obtain international accreditation (Alarifi, 2021). Also American universities are in constant improvement, starting in each program an accreditation that ends with the goal of achieving Abet accreditation as are the engineering programs at the University of San Diego (USD-University, 2022), likewise some programs already accredited are constantly evolving to the changes determined by ABET for programs that need reaccreditation as at the University of Central Missouri (Yue et al., 2019).

Latin America sees feasible the international accreditation of its programs, that is why in Ecuador the Escuela Superior Politécnica del Litoral formed a working team called ABET-ESPOL in order to show the successful experiences in this public institution to other institutions, through 9 strategies that began with the formation of the working team until the preparation for the actual visit, demonstrating that it is possible despite the time it may take to acquire accreditation (Chiluiza et al., 2013). However, the high cost of implementing these strategies in public universities may delay the achievement of these objectives, as is the case of Colombian universities, which have been adapting their systems to continuous improvement (Mejía et al., 2020), due to the requirements of new facilities, maintenance of laboratories and equipment, administrative and technical personnel, among others. Private universities are those that have established a contingency plan that has allowed them to be accredited, such as the Universidad de la Sabana with Industrial Engineering, Software Engineering and Chemical Engineering programs (UNISABANA, 2022). Likewise, several programs in Colombian universities have achieved ABET accreditation (Collazos, 2020; EAN, 2018).

The Systems Engineering program at the Universidad Francisco de Paula Santander Ocaña branch in Colombia (UFPSO), is constantly evolving through continuous improvement of educational quality at the national level, and for the year 2019 the curriculum approved the Assesment plan for the program. And decides to follow the competencies established by ABET and find the similarity with the subjects that were dictated at that time (UFPSO, 2019, 2020), establishing a plan for the years 2020-2021, taking into account 3 levels of training: basic, intermediate and high. For the year 2020, the evaluation guide, report model and competency matrix are approved, and an ABET committee is formed. All the above process is carried out through audits of the results, reviewing the documents for competency evaluation and designating the subjects per semester to be evaluated. In this context, the Programming Fundamentals course was selected for semester 2021-2. The subject is constantly updated and maintains

a research base on current topics based on the beginning of programming, as well as the indicators of attrition in the university that allow broader coverage of the university (Castrillon et al., 2021; Rincon, 2020; Rincón et al., 2020; Suarez Castrillon et al., 2020).

The objective of the research presentation is to present the methodology used in the programming fundamentals course to meet the requirements of the ABET competencies, and thus increase the percentage of approval of all subjects in order to achieve the accreditation of the systems engineering program.

2. Method

In order to obtain an adequate model to know if the accreditation requirements are met in the programming subject, two groups of students were evaluated: group A with 19 students and group B with 16 students, with 5 learning outcomes:

- Understands the operation of the elements that compose an electronic device and the relationship with the programming area.
- Identifies the design process, its phases and approaches to problem solving.
- Applies knowledge in the structure of an algorithm. Recognizes the symbols and function of flowcharts.
- Recognizes programming structures. Selects the best structure when applying it to problem solving. Understands the operation, testing of a program and the way to find errors.
- Differentiates the concepts of vectors and matrices, and knows how to apply the different processes on an array structure.

And a competency matrix is made where the type of activity developed was by means of a final written exam, evaluating 2 competencies, performance indicators, evaluation criteria and the evaluation percentage; through competency 3 and 1 of the subject of Programming Fundamentals, as shown in Table 1.

Table 1. Competency matrix

Competency to evaluate	**Performance indicators**	**Related items**	**Evaluation criterion**	**Percentage of evaluation progress**
Identify, formulate and solve complex engineering problems by applying engineering, science and mathematical principles.	Proposes solutions according to the needs established in the problem statement.	3	The student knows and uses conditional, repetitive and array-based compound data structures.	100
The ability to communicate effectively with a variety of audiences.	Produces texts that present information in an organized manner, thanks to their structure and the appropriate articulation of ideas.	1	The student can analyze the problem statements, and adequately extract all the information to create the necessary steps in	100

			data input, processing and data output.	

Fuente: Adapted from matriz de competencias Assesment (UFPSO, 2021).

For each test an evaluation rubric must be implemented, for the final exam a rubric is created based on 2 evaluation criteria, as shown in table 2.

Table 2. Evaluation rubric

	Indicators		
Evaluation criterion	**Low Level 60% (2)**	**Medium Level 80% (2)**	**High Level 100% (1)**
The student knows and uses conditional, repetitive and array-based compound data structures.	It uses single, double and multiple conditionals.	Uses repetitive structures.	The student uses matrices or vectors for the solution using different repetitive structures in the program (While, For, Repeat).
The student can analyze the problem statements, and adequately extract all the information to create the necessary steps in data input, processing and data output.	The student performs a manual desktop test before coding the program.	The student extracts input and output data, and defines data types and variables.	The student creates expressions and formulas, suitable for coding.

Source: adapted from Evaluation Guide and Rubric (UFPSO, 2021).

The general observations of the evaluation method of the final exam are also explained and specified, making very clear each one of the points, to avoid confusion and so that the student knows the reason for his final grade. The guidelines are made based on the following:

- The exam will be done between two students, placing inside the source code of each program the name and code of each student.
- The development of the problem must be done on this document, after the content of the evaluation in the spaces where it is indicated to attach your solution and must be delivered in text file to be edited (in case your file weighs more than 5MB please upload it to Google Drive enable permissions to the teacher and attach the URL in the Univirtual platform otherwise your delivery will not be registered).
- This document must be submitted in Word format and additionally the two source programs in Pseint in the Uvirtual.
- The deliveries are only received by Univirtual, deliveries by email or WhatsApp or any other means will not be accepted.
- The delivery of the exercise will take place on the assigned day in the Univirtual from 02:00 hours on December 7.
- The socialization of the first point will be done virtually and will have a maximum duration of 10 minutes per group according to the schedule agreed with each group.
- The grade for each of the points presented in the exam will only be given once the source programs have been reviewed.

- During the presentation of the first point, questions will be asked on each of the items that make up the exam to verify the appropriation of the concepts and their application.

The content of the evaluation focuses on the subject matter as follows:

- Develop the analysis of the program with its input data, process, and output, specifying variables, data types, formulas and a manual analysis in the form of a desktop test.
- Develop a pseudocode to evaluate the repetitive structures.
- Develop a pseudocode to evaluate repetitive structures and arrays.

3. Results

The activities developed for the first competency are shown in Table 3.

Table 3. First ABET competition

ABET COMPETITION	**LEVEL OF COMPETENCE**					**KPI-ACHIEVEMENT-PERFORMANCE**		**ACTIVITY**		**RUBRICA**	
	C	A	E	A	D					SI	NO
1- Identify, formulate and solve complex engineering problems by applying engineering principles, science and mathematics.	X	X	X	X	X	1	Recognizes basic concepts and procedures and applies them to problem solving	1,3	Exam		X
						2	Proposes solutions according to the needs established in the problem statement.	1,3	Workshop		X
						3	Performs abstractions and mathematical modeling of reality.	1	Readings	X	
								1	Quizz		X
								2	Project	X	
								2	Practices	X	
								1,3	Exercises		x

The results of the first competition with 19 students evaluated from group A and 2 withdrawn students, show that all the scores were high, according to the percentage of the levels and the minimum grade: Low level 60% with 0, Medium level between 60% and 80% with 2.4 and High level 80% and 100% with 3.2. The average grade obtained a 3.9, with an ideal percentage of approval of 70%, for this case 100% was obtained (Figure 1).

For group B with 16 students, the average grade was 3.3, with a high level of 10, medium level of 3 and low level of 3. The ideal percentage of approval of 70% was 13 above 11.2.

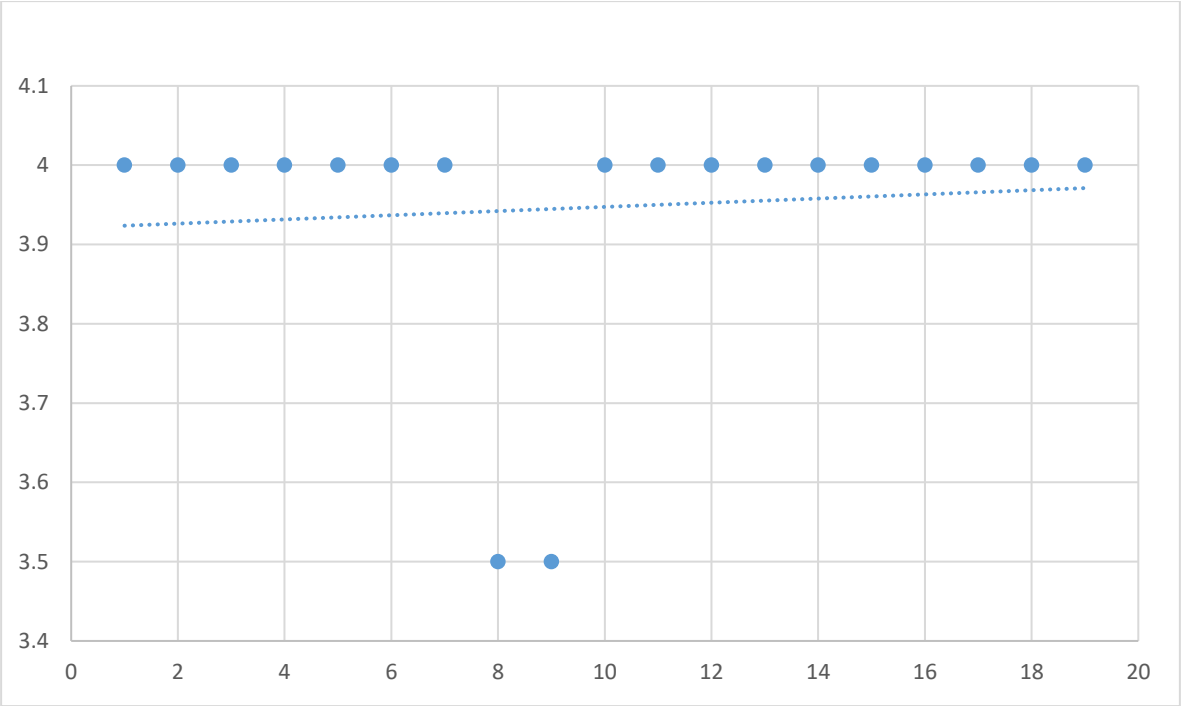

Figure 1. Data analysis first competence group A

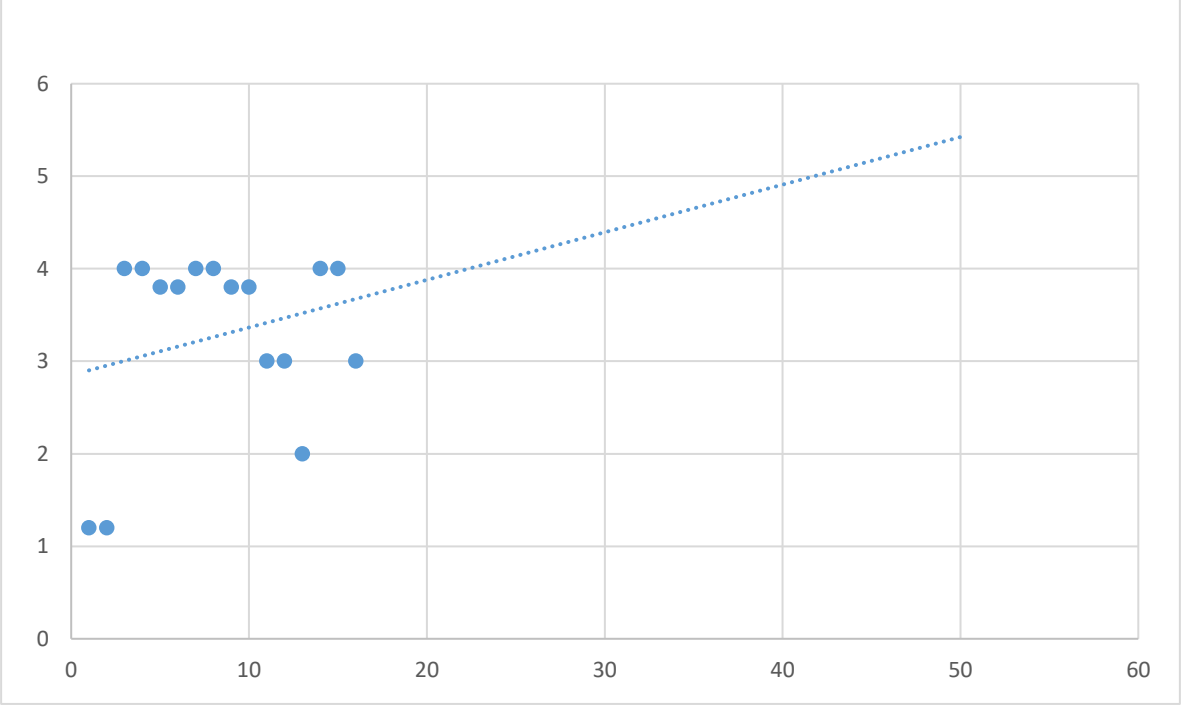

Figure 2. Data analysis first competition group B

For the second competency framed with item 3, the activities in Table 4 were developed, focused on the form of presentation and communication of each student, reflecting their knowledge.

Table 4. Second ABET competency item 3

ABET COMPETITION	LEVEL OF COMPETENCE	KPI-ACHIEVEMENT-PERFORMANCE	ACTIVITY	RUBRICA

	C	A	E	A	D					SI	NO
3- The ability to communicate effectively with a variety of audiences	X	X	X	X	X	1	Performs presentations with coherence according to a specific topic	1,2	Exposition	X	
						2	Socializes the information he/she possesses with his/her peers in the search for an adequate solution to a problem situation.	1,2	Discussion	X	
						3	Produces texts that present information in an organized manner, thanks to their structure and the appropriate articulation of ideas.	3	Reports	X	
								3	Article	X	

Out of 19 students in group A in competency 3, 11 have high level and 8 have medium level, with average score of 0.9, where low level 60% with 0, medium level between 60% and 80% with 0.6 and high level 80% and 100% with 0.8. The ideal percentage of 70% is 13.3, while the actual level was 19 (Figure 3).

For the second group with 16 students, a high level was obtained in 12 and 4 in medium level, with an average score of 1.0. The ideal percentage of 70% is 11.2, while the actual level was 16 (Figure 4).

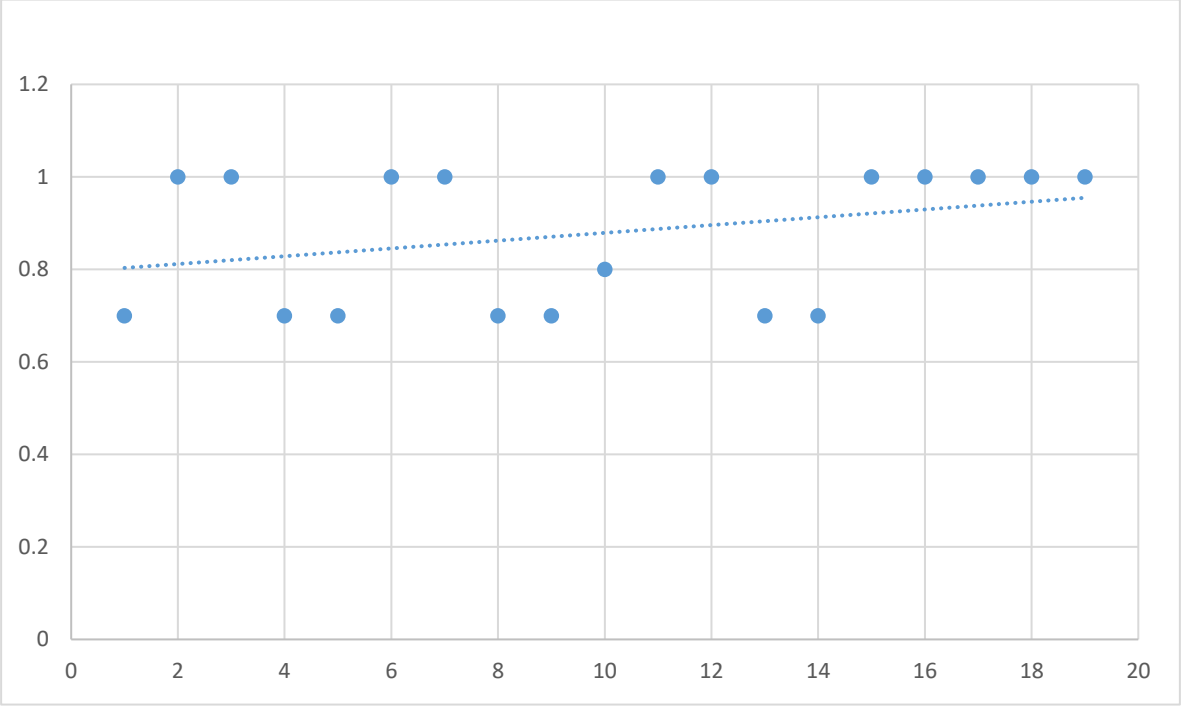

Figure 3. Data analysis second competency item 3 - group A

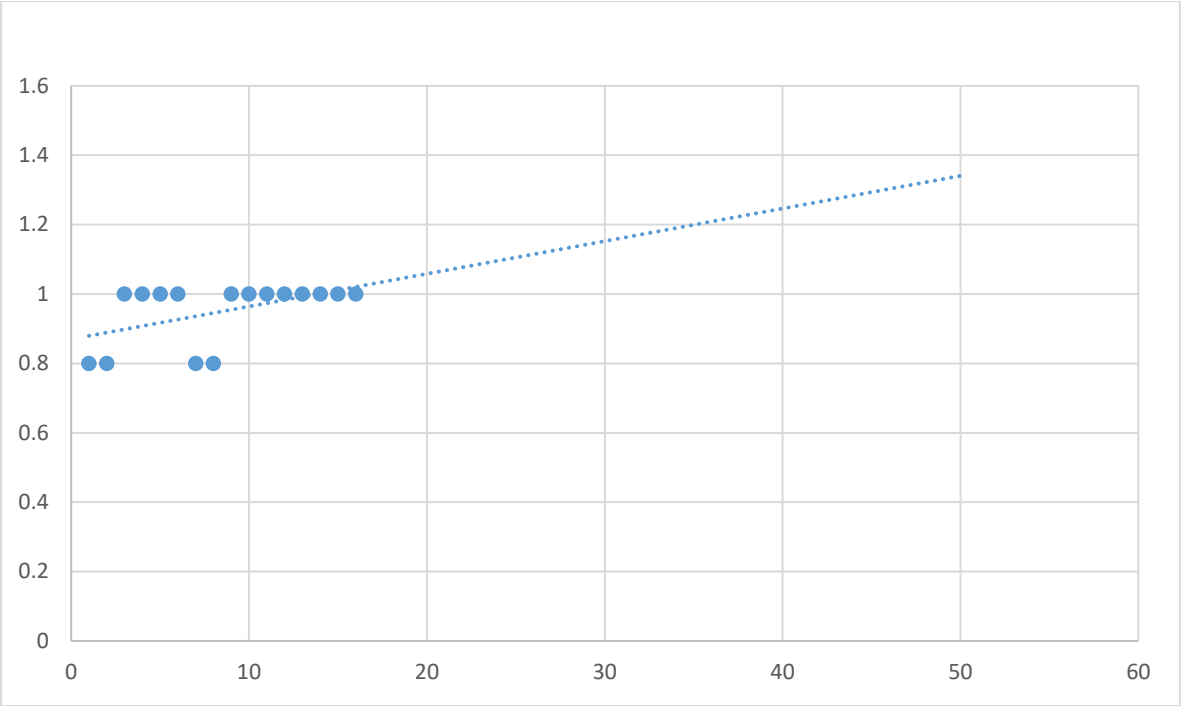

Figure 4. Analysis of data second competency item 3 - group B

The results show that the level of the students is high, and after the evaluation by the Systems Department through 3 evaluators, an average grade of 4.0 out of 5.0 was obtained, satisfactorily fulfilling the corresponding requirements for the evaluation of competencies. Among the recommendations are the updating of the micro-curriculum, the use of current bibliographic databases that exist in the university library.

4. Conclusions

The ABET competencies reflected the importance of the learning results, making it possible to know if the students are prepared to continue with subsequent subjects, as well as to provide security to the graduate, who will be more prepared for the working world. The subject through the implemented model meets satisfactory results, which are in 80% of approval, that is why improvements should be implemented to raise the level of quality, and thus prepare for international accreditation of the entire systems engineering program, also allows to know where it can be located a program in the national and international context.

References

ABET. (2022). *ABET | ABET Accreditation*. https://www.abet.org/

ACOFI. (2022). *Modelo de Acreditación ABET | ACOFI | Asociación Colombiana de Facultades de Ingeniería*. http://www.acofi.edu.co/modelo-de-acreditacion-abet/

Alarifi, I. M. (2021). Comparative Analysis on Regional (NCAAA) and International (ABET) Accreditation for Mechanical Engineering Program. *Engineering Technology Open Access Journal, 3*(5), 1-16. https://doi.org/10.19080/ETOAJ.2021.03.555621

Castrillon, A. M. S., Serrano, E. G. F., & Castrillon, A. S. (2021). Model for the Generation of Digital Academic Certificates. *Int. J. Eng. Res. Technol*, *14*, 298-331.

Chiluiza, K., Wong Villacrés, M., & Duque, J. (2013). *En búsqueda de la acreditación ABET: Estrategias exitosas en una institución de educación superior pública de Sudamérica*. http://www.laccei.org/LACCEI2014-Guayaquil/RP126.html

Collazos, C. F. P. (2020). *Tres ingenierías de la Universidad Icesi cuentan con acreditación internacional ABET*. https://www.icesi.edu.co/unicesi/todas-las-noticias/6111-tres-ingenierias-de-la-universidad-icesi-cuentan-con-acreditacion-abet

EAN. (2018). *Ingeniería de Producción renovó su acreditación ABET | Noticias*. Universidad EAN. https://universidadean.edu.co/noticias/ingenieria-de-produccion-renovo-su-acreditacion-abet

Elnajjar, E., Omari, S.-A. B. A., Omar, F., Selim, M. Y., & Mourad, A. H. I. (2019). An Example of Abet Accreditation Practice of Mechanical Engineering Program at UAE University. *International Journal for Innovation Education and Research*, *7*(8), Art. 8. https://doi.org/10.31686/ijier.vol7.iss8.1697

Faiz, M. M. U., & Almutairi, M. S. (2021). On the ABET accreditation of academic programs and rankings of universities in Saudi Arabia. *2021 World Engineering Education Forum/Global Engineering Deans Council (WEEF/GEDC)*, 270-276. https://doi.org/10.1109/WEEF/GEDC53299.2021.9657262

Iqbal Khan, M., Mourad, S. M., & Zahid, W. M. (2016). Developing and qualifying Civil Engineering Programs for ABET accreditation. *Journal of King Saud University - Engineering Sciences*, *28*(1), 1-11. https://doi.org/10.1016/j.jksues.2014.09.001

Mejía, G., Caballero-Márquez, M. M., Huggins, K., & Bautista-Rozo, L. X. (2020). ABET Accreditation in Colombian Higher Education Institutions: Opportunities and Barriers. *Revista UIS Ingenierías*, *19*(4), 239-250.

Rashideh, W., Alshathry, O., Atawneh, S., Bazar, H., & AbualRub, M. (2020). A Successful Framework for the ABET Accreditation of an Information System Program. *Intelligent Automation & Soft Computing*, *26*, 1285-1307. https://doi.org/10.32604/iasc.2020.012995

Rincon, I. (2020). Y AM Suarez,«Incidencia de COVID-19 en la inscripción de estudiantes a los programas de educación superior». *Espacios*, *41*(42).

Rincón, I. K., Suárez, S. A., & Suarez, A. (2020). Impacto del programa Jóvenes en Acción en la deserción estudiantil en tiempos de Covid-19. *Espacios*, *41*(42), 304-315.

Suarez Castrillon, A. M., Rincon, I. K., & Suarez, S. A. (2020). Impacto del programa Generación E en la Educación Superior durante el COVID-19. *Revista Espacios*, *41*(42), 304-314.

UFPSO. (2019). *ACTA No.0020 Comité Curricular Plan De Estudios Ingeniería De Sistemas*. https://uvirtual.ufpso.edu.co/pluginfile.php/84134/mod_resource/content/2/ACTA%20No.0020%20del%2020%20de%20diciembre%20del%202019-PDF.pdf

UFPSO. (2020). *ACTA No.002 Comité Curricular Plan De Estudios Ingeniería De Sistemas*. https://uvirtual.ufpso.edu.co/pluginfile.php/84137/mod_resource/content/1/ACTA%20No.0002%20DEL%2019%20DE%20FEBRERO%20DLE%202020-convertido.pdf

UFPSO. (2021). *Curso: ABET 2020—2021*. https://uvirtual.ufpso.edu.co/course/view.php?id=552

UNISABANA. (2022). *Abet*. https://www.unisabana.edu.co/englishversion/la-sabana/news/abet/?L=0

USD-University. (2022). *All USD Engineering Degree Programs Achieve ABET Accreditation—University of San Diego*. https://www.sandiego.edu/news/detail.php?_focus=86298

Yue, X., Copus, B., Park, H., Yousef, M., & Tian, S. (2019). Revising an accredited computer science program at a public regional university to meet new ABET guidelines. *Journal of Computing Sciences in Colleges, 34*(4), 18-23.

Zaid Abualkishik, A., Atassi, R., Singh, A., Elhoseny, M., Alwan, A. A., Iqbal, R., & Khelifi, A. (2022). Outcomes-Based Assessment and Lessons Learned in ABET-CAC Accreditation: A Case Study of the American University in the Emirates. *Mobile Information Systems, 2022*, e1595126. https://doi.org/10.1155/2022/1595126