Evaluation of learning and performance indicators in virtual classroom for generations 2016- 2021 TecNM-Campus Boca del Río, Veracruz, Mexico.

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Summary – In March 2020, the world experienced an emerging situation: "the COVID-19 pandemic". Academic institutions should implement a new teaching-learning modality as soon as possible. The need to implement education in virtual mode caused a 360° turn in both teachers and students. The present research work evaluated learning and performance indicators in the virtual classroom in the 2016-2021 generations of TecNM-ITBoca. It was a quasi-experimental research with quantitative main status and qualitative secondary complement with implementation of sequential methods explanation-understanding, holistic-analytical.

The experimental basis was based on empirical-analytical methodologyapplied by an analysis of variance α=0.05; qualitatively, the methodology of interpretation that founded the elaboration of Topological Triangles was applied. 126 students of the 7th semester of the careers participated: Management-Business, Engineering-in-Aquaculture and Engineering-Civil, generation August-2016-August-2021.

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The experimental basis was based on empirical-analytical methodology applying an analysis of variance α=0.05; qualitatively, the methodology of interpretation that founded the elaboration of Topological Triangles was applied. 126 students participatedbefore the 7th semester of the careers: Business-Management, Engineering-in-Aquaculture and Civil Engineering, generation August-2016-August-2021. The results for academic averages 2019-2, 2020-1 were I.Acua=76.92, 77.4; I.Civil=70.03, 71.47; Ges.Empr: Logistics-Port=82.71, 83.19; Leadership-e-Innovation: 82.87, 83.94; Tourism=78.28, 79.94. Performance Indicators ID-Acua: 46.15%=Notable; 15.38%=Good; 23.0%=Sufficient; 15.38%=Insufficient. ID-Civil: 38.57%=Good; 26.31%=Sufficient; 35.08%=Insufficient. ID-Ges.Empr for Port Logistics: 1.76%=Excellent; 33.92%=Notable; 37.5%=Good; 12.5%=Sufficient; 12.5%=Insufficient.

Leadership and Innovation 40.62%=Notable; 43.75%=Good; 3.12%=Sufficient; 12.5%=Insufficient. Tourism 40.62%=Notable; 43.75%=Good; 3.12%=Sufficient; 12.5%=Insufficient. It is concluded that there are no significant changes in the academic averages of the three careers; however, all had atertions. The construction of Topological Triangles for learning in the virtual classroom validated the following categories: attitudes, behaviors and values; conefoundations, skills and abilities; degree of participation in external activities, autonomous, collaborative and discovery work; permanent training in virtual spaces and management of software for experimentation.

Index of Terms – Evaluation, Virtual Classroom, Performance Indicators, Learning.

I. INTRODUCCION

Los avances científicos y tecnológicos en apertura al siglo XXI, have generated great transformations in the impact of computing and telematics were the beginning of the rapprochement between all human beings on the planet which caused a redefinition of life expectations.

At the end of December 2019, an announcement shook the whole world, the SARS-CoV-2 virus (COVID-19), invaded China and subsequently contaminated Europe and Soa; by the beginning of March 2020 it was detected in Mexico; which led to the closure of activities and several sectors of society including education.

To respond to the demands, which this situation provoked; the Tecnológico Nacional de México Campus Boca del Río, a higher level institution, implemented the use of virtualclassrooms to give continuity to the professional training of young people and citizens, capable of facing a new reality, through the development of thinking skills, such as the cognitive processes you use when you learn. However, now more than before, there is a need to build skills in the subjects of learning, so that they respond autonomously to the problems by applying what they have learned during their professional training and later when inserting themselves in the productive and community sector.

Based on the above, this research evaluated learning and performance indicators in the virtual classroom in the 2016-2021 generations of the TecNM Campus Boca del Río. In addition to knowing how their professional training was oriented through pedagogical practice, which included the construction and development of cognitive bridges, which met the benchmark of being: this permanently and for respond both to their needs, to aspireto and values, and to the desires of the society in which they are immersed.

II. EL PROBLEMA Y EL PROPÓSITO

A well-organized knowledge base offers the possibility of generating a significant improvement in situated, discovery and collaborative learning; since cognitive skills are linked to the learning strategies used during academic training [3], [9], [10].

The educational training of teachers involved the development of work plans focused on learning in the virtual classroom, whose purpose was to achieve and exchange knowledge through the development of academic activities using multiple platforms: meet, teams, classroom, zoom; to name a few.

The teacher-student binomial began at the beginning of April 2020, with virtual classes and continuous teacher and student training. In the deployment of the educational model for the twenty-first century presented by theNational System of Higher TechnologicalEducation, the educator must commit himself to act in favor of a better future for society, since stable and competitive growth allows as a basis an inclusive society with opportunities for all [16].

With the participation of 126 students of the 7th semester of the careers: Business Management, Aquaculture Engineering and Civil Engineering, generation August-2016-August-2021; and 35 teachers respectively, a distance *education* model was implemented, with the use of applications digital to guarantee the student-teacher communication channel, the evaluation activities to assess learning, the development of knowledge and the interaction with the group in the classrooms v irtuales.

Inview of the above, the following general objective was proposed:

Evaluate learning and performance indicators in the virtual classroom for generations 2016-2021 of the TecNM-Campus-Boca-del-Rio.

III. MARCO TEÓRICO CONCEPTUAL

A. *Educational* Model *for the XXI Century*

The model implemented in 2004 by the National System of Technological Higher Education (SNEST) in its Educational Institutions; is a dynamic conception that articulates the Philosophical Dimension conformed by philosophical principles, a shared vision of the SNEST and its commitment to humanity, code of ethics and values; in addition to the Academic Dimension for vocational training, the conception of learning and educational practice; finally the principle of the Organizational Dimension for educational administration for high performance, process management and leadership in the SNEST [16].

This model is enriched by innovation and quality processes since by applying planning, academic activity, linkage and administration as guiding axes, the coordinates of all the processes and activities that are carried out are integrated. in SNEST.

Its value lies in the formation of human capital, with professionals incorporated into Mexican society to meet the specific and strategic demands on the issues of scientific and technological development with holistic and innovative perspectives.

B. *Of the learning processes: know-how, know how to be, know how to* act and know how *to innovate.*

The shared vision of processes and knowledge articulates educational practice, research, linkage and dissemination from the perspective of a humanist vision that is permeated by the experience of history. Which marks results with great ends because science, technology, art and culture come together. This is how the processes and the development of knowledge consolidate one of the fundamental pillars of sustainable, sustainable and equitative development; and contributes significantly to the improvement of the quality of life and multiculturalism of the country [7].

In each process, during the learning that the teaching staff, teaching support and students acquire, there are exchanges between institutions that positively strengthen academic, cultural and inclusion activities; which enriches the vocational training of all [8].

C. *Competences, development and application*

They are skills that everyone has, some more less developed; but certainly all can be competitive. In general, the competences have to do with the development of integral formation, which imply the faculties of being, knowing, doing and innovating; of respect for our person and with whom coexistence is carried out daily, being inclusive, tolerantof diversity, since it must be understood that the teams of work are unique and unrepeatable [1], [2].

During the construction process, the incorporation of the concept of sustainable development is again present, seen as a social development that allows respect and care for the planet's resources (renewable and non-renewable) to generate a better quality of life, therefore collaboration and social responsibility are a challenge in the planning of academic activities to develop skills that are handled in the transversal plane of the curriculum in all the careers of the SNEST and maintain a balance between autonomous and collaborative work for the academic training activities [17].

D. *Virtual Education, the new concept* in *education*

The continuity of the COVID 19 pandemic and its direct relationship with learning processes undoubtedly disrupt what teachers call the knowledge society. Why? due to the demanding need to look for alternatives, to continue providing education, one of them was Virtual *Education.*

The universal concept for virtual classrooms is defined as reserved and exclusive spaces for teachers and their students; teachers of academic bodies and / or collegiate that belong to an Educational Institution and that have their registration / enrollment since with their personal access code theycan carry out activities inherent in the courses they teach; with a particular characteristic that the contents are available throughout the school semester or semester [12].

Education from this perspective, that is, virtual; characterized each of the activities related to it: virtual classes, virtual laboratories, virtual evaluations, to name a few. Its implementation was important as it reduces "learning barriers" with the opportunity for students to learn without sharing a space. In addition, it involved core transformations in the training of participants for the use of institutional platforms, equipment, in addition to; lose the fear of change, attitude and patience.

IV. MARCO METODOLÓGICO

The study considered all students of the seventh semester of the August 2016 – August 2021 generation, who experienced the change in the teaching-learning process due to the COVID-19 pandemic.

1) Ework team composed of:
➢ Three career heads: Marine Sciences, Economic-Administrative and Earth Sciences,
➢ 35 professors of the careers of Engineering in Aquaculture, Engineering in Business Management and Civil Engineering.
➢ 126 students of the 7th. semester of the careers: Aquaculture Engineering, Civil Engineering and Business Management Engineering, generation August-2016-August-2021. The participating specialties were: Aquaculture Biotechnology; Maritime Works; Port Logistics; Leadership and Innovation and Tourism.

2) Place of Study:

The study was carried out at the Tecnológico Nacional de México, Boca del Río Campus (Fig. 1) El ITBoca, located on the Veracruz-Córdoba Highway Km.12 C.P. 94290. Boca del Rio, Veracruz, Mexico; the coordinates are 19°5'48"N 96°6'30"W, next to the mouth of the Jamapa River.

Fig. 1 Panoramic view of ITBoca

The academic activities were carried out from the different homes of the students and their teachers.
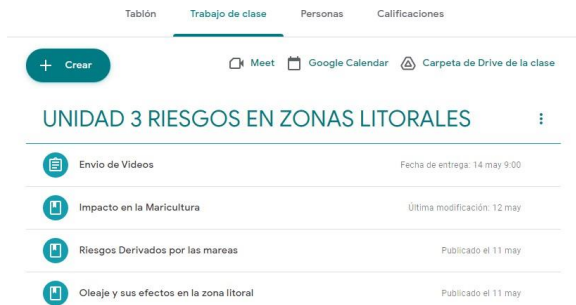
(Figures 2, 3a and 3b)

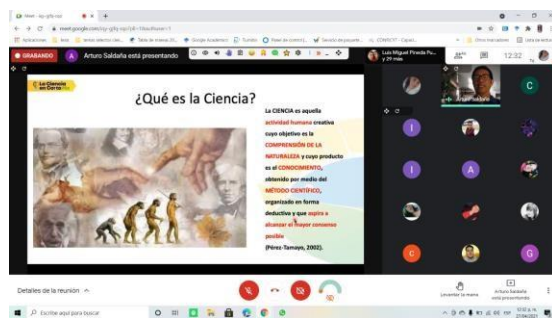*Fig. 2 Academic activity using support platforms* in *Virtual* Classroom

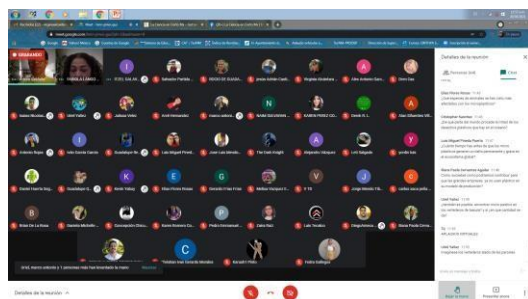*Fig. 3a What is Science?* *Virtual* Class

Fig. 3b The dynamics in Virtual *Class.*

3) Type of Research

The study was a quasi-experimental investigation, with quantitative primary status and qualitative secondary complement. It involved a complementary DICO design, with sequentially implemented methods: deduction-induction, explanation-understanding, holistic-analytical and synccridy-diachrony.

The type of comprehensive design called complementation has two distinct images of socialreality. The minimum level of integration design has two methodological structures (different purposes and results) and gives rise to a report with two parts: a quantitative and a qualitative or vice versa [4], [5], [6].

4) Stages of Research

The quantitative approach was based on the observable and quantifiable aspects, which is why the empirical-analytical methodology and basic statistics were applied for the analysis of the results [11]. The qualitative approach studied especially the meanings of human actions and social life, using the methodology of interpretation, focusing on the discovery of knowledge [13], [18].

The research was divided into two phases: the quantitative phase Was Validated a through of the average academician Obtained during the semester, for which the capture of each student's report card data, and posteriormente during the periods 2019-2 and 2020-1 and was applied a Anova ($\alpha=0.05$) to determine its impact on learning and performance levels of careers and their Specialties.

The qualitative approach was interested in understanding human behavior from the very frame of reference of the one who acts, that is, he handled a perspective from *within,* and was oriented to discoveries. The content analysis was carried out from the teaching reports that each professor given to his academic department, to obtain the categories for the construction of the topological triangles. In this phase the following characteristics were included: the students and their space, considered as a cultural context and a historical process of a here and now (everyday life); their ethics which is described and transcribed; the interpretation of the meanings during the class (the semico); the dynamic and changing, already in each class the process is in continuous reconstruction and finally the multifaceted through the word, image, signs, tones of voice, material culture.

5) Of the Virtual Academic Activities

The teachers participating in the experiment worked with their programmed activities according to the group's assignment. In turn, they delivered three scheduled reports, in which the relevant points during the semesters were contemplated. The teachers and the researcher scheduled five meetings during the course, at the end and after each report was delivered.

The virtual classroom, as a space for the exchange of knowledge and learning, was an important factor in the development of the research. Theplatform used allowed the use of different applications that include, the search and playback of videos, links, files, as well as the monitoring of the content of each subject, roll call, participation in situ of the students, delivery of tasks and evaluation of the same. Which were used to fulfill the competence to be developed in each learning unit.

The indicators implemented to define academic achievement were: Observation, classification, selection, measurement, description, exemplification, analysis and innovation. Categories of analysis: Process, teaching and learning, development of attitudes and learning of values, knowledge, skills

and skills, Actions in favor of the environment and social, psychological and cultural perspective. Classification levels: excellent 95-100, remarkable 85-94, good 75-84, enough 70-74 and not yet credited 0-69.

6) Information Collection

Self-reports, that is, evaluation of the portfolios of evidence made by each student, in which they provide information about themselves. Through which information was obtained on habits and attitudes, which through an objective test can not be measured. With this instrument the student expressed his way of acting in different situations during the process.

The video recording was used as anobservational system, consisting of the filming of the activities carried out by the students both in the classroom, as well as in the laboratories, trainings and virtual visits. Topological representation was used as a tool to respond to the objectives of the research and complement quantitative information with qualitative information.

To achieve this, topological triangles were elaborated. The structure was made up of three elements that theoretically were related to meaningful and situated learning, autonomous, collaborative and discovery work. In addition, permanent training in virtual spaces and management of software forexperimentation. Each of these elements were selected because in them an internal dynamic was found that favored the establishment of the processes: knowledge, skills and abilities; teaching-learning; values, activities and behaviors; organization, approach and resolution of problems and social, psychological and cultural perspective.

7) Validity of the Research

According to Villalobos [19], the results should reflect what happens during the research process, which is why the variables are known as sources of internal and external disability. There are four validity criteria in the evaluation of quantitative research designs: internal validity, external validity, construct validity and statistical conclusion validity.

V. RRESULTS

The results for the evaluation of learning and performance indicators in the virtual classroom in the 2016-2021 generations of the ITBoca-TNM, are presented below:

• Learning levels in the virtual classroom.

Figures 4 and 5 represent the academic average of the students of the generation of the Aquaculture Engineering career during the periods 2019-2 to 2020-1 with values

of 83.21 and 83.39, respectively. The academic achievement did not show significant differences in the individual and accumulated results, for the specialty of Aquaculture Biotechnology.
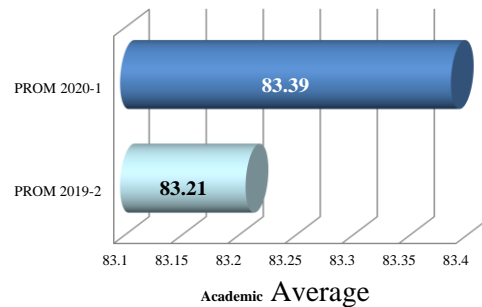

Fig. 4 Accumulated academic average of the students of the Aquaculture Engineering career in the periods 2019-2 and 2020-1.
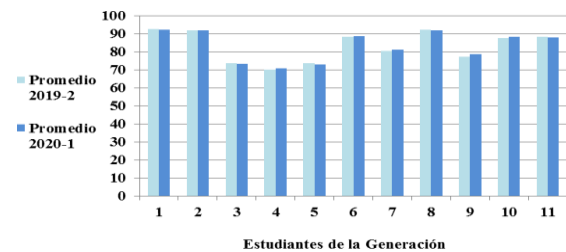

Fig. 5 Individual academic average of the students of the Aquaculture Engineering career in the periods 2019-2 and 2020-1.

Figures 6 and 7 represent the academic average of the students of the generation of the Engineering in Business Management career during the periods 2019-2 to 2020-1 cumulatively. The results showed no significant differences.
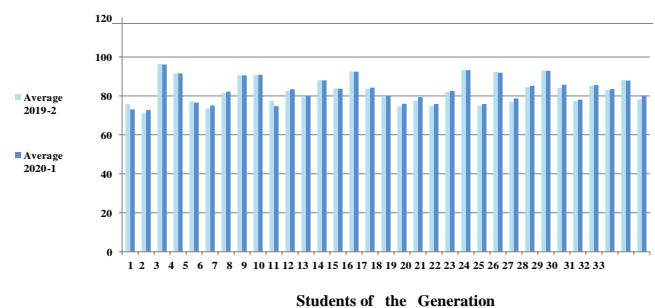

Fig. 6 Individual academic average of the students of the career Engineering in Business Management period 2019-2 and 2020-1.
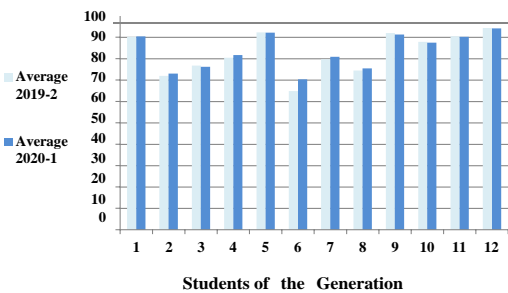
Fig. 7 Individual academic average of the students of the career Engineering in Business Management period 2019-2 and 2020-1.

The accumulated academic achievement of students in the specialty of Port Logistics showed values of 82.71 and 83.19 for 2019-2 and 2020-1, respectively (Fig. 8); for the specialty of Leadership and Innovation the results were 82.87 and 83.94, respectively (Fig. 9), and for the specialty of Tourism the average acad The emium was 78.28 and 79.94 for the 2019-2 and 2020-1 periods, respectively. It is important to mention that significant differences were observed in the averages of Port Logistics and Leadership and Innovation, compared to Tourism; which is found with an academic average corresponding to the level of sufficient performance.
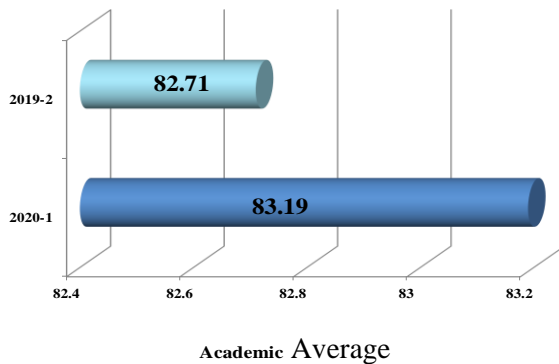

Academic Average

Fig. 8 Accumulated academic average of the students of the career Engineering in Business Management specialty Port Logistics in *the periods 2019-2 and 2020-1.*
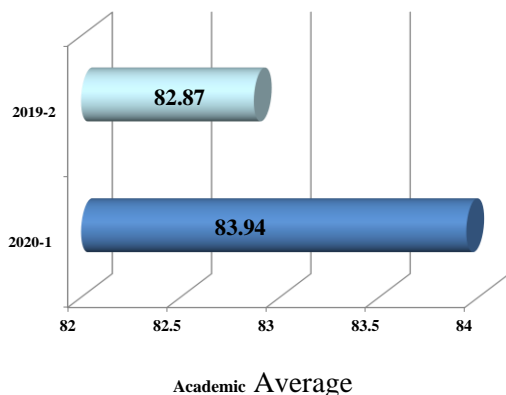

Academic Average

Fig. 9 Accumulated academic average of the students of the career Engineering in Business Management specialty Leadership and Innovation in the periods 2019-2 and 2020-1.
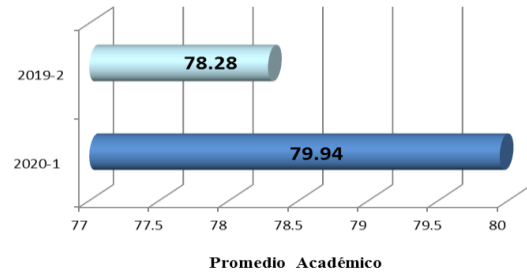

Fig. 10 Accumulated academic average of the students of the career Engineering in Business Management specialty Tourism in the *periods 2019-2 and 2020-1.*

The individual academic average of the students of the Civil Engineering career (Figures 11 and 12), was 64.50 and 73.80 in the semesters 2019-2 and 2020-1, respectively. With respect to the cumulative average, significant differences were observed, from: competence not yet accredited to sufficient.
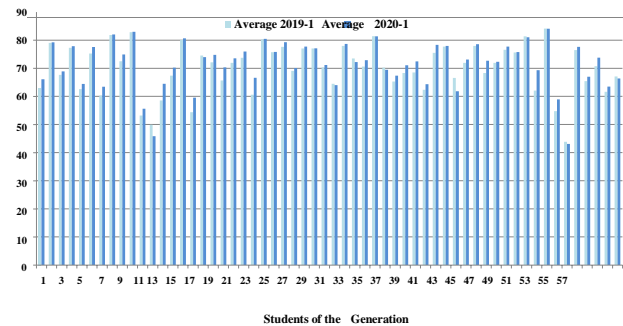

Fig. 11 Individual academic average of the students of the Civil Engineering career specialty Maritime Works in the *periods 2019-2 and 2020-1.*
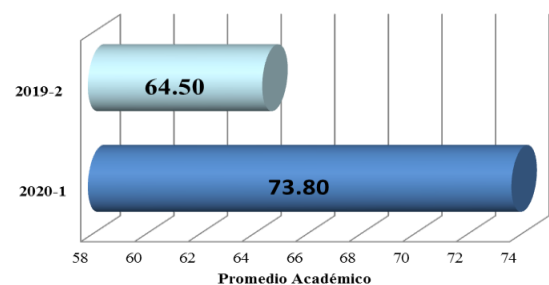

Fig. 12 Accumulated academic average of the students of the Civil Engineering *career* specialty Maritime Works in the periods *2019-2 and 2020-1.*

- Performance indicators in the virtual classroom in the 2016-2021 generations of the TecNM-Boca del Río Campus.

The determination of the performance indicators present the levels at which the students developed their generic and specific competences according to the thematic content of the subjects in their respective

Specialties. Table 1 shows the level of performance andits relationship with theindicators of scope and range of numerical valuation.

Board 1. Level of performance indicators of scope and its assessment numerical

Performance level	Outreach indicators	Assessment numerical
Excellent	It fully complies with the achievement indicators excellently.	95 - 100
Notable	Meets 5 of the defined indicators in excellent performance.	85 - 94
Well	It meets 4 of the indicators defined in excellent performance.	75 - 84
Enough	Meets 3 of the indicators defined in excellent performance.	70 - 74
Insufficient	100% of conceptual evidence is not with	NA (not reached)

Figures 13 to 17 present the results of the performance indicators for Aquaculture Engineering specializing in Aquaculture Biotechnology, which obtained 46.15% of its students at the Notable level; the Insufficient indicator was significant, with a 15.38% representativeness with respect to the level of performance Good.
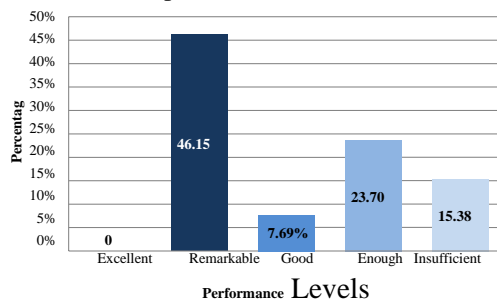

Fig. 13 Performance indicators for Aquaculture Engineering specialty Aquaculture Biotechnology

In Civil Engineering the performances are at Good levels with 38.57% and Sufficient with 26.31%; it is significant to note that this specialty showed high reprobation reflected in the Insufficient value with 35.08%, and that the levels of Excellent and Remarkable do not were introduced.
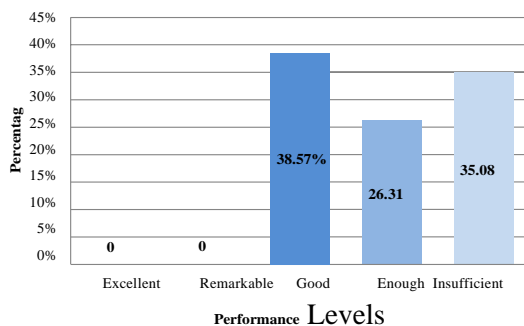

Fig. 14 Performance indicators for Civil Engineering specialty Maritime Works

The career of Engineering in Business Management, presented the following levels of performance in its specialties: Port Logistics 12.5% Insufficient, 1.76% Excellent and Good with 37.5% as the highest level reached.
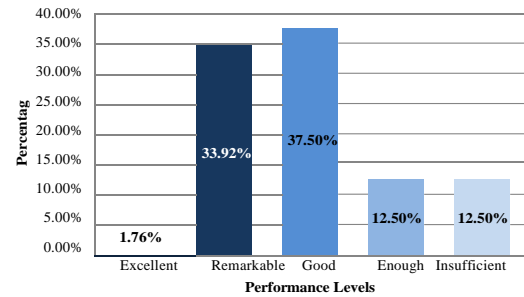

Fig. 15 Performance Indicators for Engineering In Business Management specialty Port Logistics

The specialty of Leadership and Innovation presented insufficient performance levels 12.5%, Notable 40.62% and Good level 43.75%.
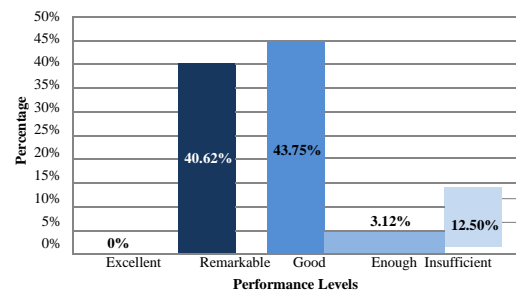

Fig. 16 Performance Indicators for Engineering In Business Management specialty Leadership and Innovation

Finally for the specialty of Tourism the levels of performance were Remarkable and Sufficient with 27.75%, Insufficient with 9.09% and with 36.36% in Good level.
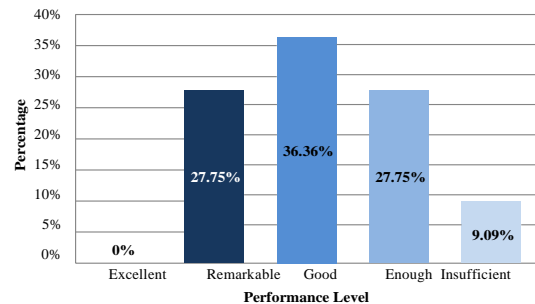

Fig. 17 Performance Indicators for Business Management Engineering specialty Tourism

- Triangles-topological in virtual classroom, in the generations 2016-2021 of the TecNM-Campus Boca del Río.

The structure of the topological triangle (Figure 18) was made up of three elements at the base, meaningful learning, situated learning, and discovery learning [2], [9], [10]. On the left side, autonomous and team work; on its right side, permanent training in virtual spaces and in its base In the central curtain the elements selected for an internal dynamic that favored the establishment of the processes: knowledge, skills and abilities; teaching–learning; values, attitudes and behaviours; organization, approach and resolution of problemas and social, psychological and cultural perspective.

Fig. 16 Topological Triangle concentrator of learning processes in virtual classroom in the generations 2016-2021

VI. ANALYSIS OF RESULTADOS

It is evident that in this adaptive learning process, innovation, training and research were three moments applied by all those involved, mainly teachers who, faced with radical change for many, implemented strategies to act on objectives and competencies in their subjects. LoPriore and Anzola [14], in their study of innovative didactic experiences analyze the changes in the teaching method and practice and reveal the imminent need for active participation of students; it is a fact that in the results obtained the leadership specialties and innovation were the ones that best adapted to this change, since they did not present failures or failed students.

The career of Engineeringin Aquaculture and his specialty in Aquaculture Biotechnology does not present significant differences in his average academic achievement. The observations to this generation were that there were two temporary casualties.

The career of Civil Engineering and its specialty of Maritime Works presented significant differences in its average of academic achievement since it was in the lower limit with values of 73.80 which refers to Sufficient performance levels. The students explain that it was due to the lack of face-to-face complementation activities

of field practices and workshops, weakening their procedural activity and with it demotivation.

The career of Engineering in Business Management also showed significant difference, in the specialty of Tourism, with performance indicator Good; but with values of academic achievement with accumulated average of 78.9; this is related to the marked difference between "live" vs "virtual" visits, to characterize for example "the magical towns" since not being able to carry out their presentations interactively with their peers, the unit does not re presented *creativity* in their exercises since during the semester *live* presentations were scheduled to evaluate their thematic units.

The integral topological triangle showed that the five specialties made changes in their activities, with innovative cut trials to sequence the actions and carry out meaningful learning. It was also implemented synchronous and asynchronous through virtual spaces [8], [15].

The interpretive fabric in its backdrop shows how the learning spaces in the virtual classroom are very different from a living classroom, the interaction between the student and the teacher was not planned in advance for distance education, this has generado problematic areas for autonomous and teamwork; since the training although permanent was not standardized, the Institution allowed free chair and choice of platforms with free will.

VII. CONCLUSIONS

There are no significant differences within the groups, that is, their ratings were not increased to the level of immediate superior performance; however, there were some temporary losses.

The learning spaces in the virtual classroom are veryand different from a living classroom, but it is important to adjust the educational quality with the new virtuality, which leads to a systematization of the teaching-learning processes.

The didactic strategies applied revealed that during the process, it was necessary to re-build friendly environments to promote a global and integrated vision that is the basis for obtaining better academic performance and high performance.

Motivation as a turning point implied its necessary and continuous presence during classes, it is essential that the teacher renews the way of teaching and developing activities that encourage interest in learning in their students.

It is important to consider innovation models that implement face-to-face activities and also activities.

virtual in a binomial not of competition but of complementation.

Finally, the evaluation during virtuality was an instrument of high importance in the generation of change and innovation, for organization, approach, problem solving and social, psychological and cultural perspective.

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