Enveloping analysis of data from educational platforms by area of knowledge

Análisis envolvente de datos de las plataformas educativas por área académica

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Keywords
Envelope analysis; digital platforms; long-distance education; COVID-19; Mexico

ABSTRACT

In the presence of the pandemic caused by Covid-19, digital platforms were implemented to continue with the education processes from isolation. In the case of higher education that imparts various areas of knowledge, different results were identified in the use of the same digital platforms. In response to this, it was necessary to analyze how the technological characteristics implemented at a higher level in Mexico have influenced the participation, attendance and evaluation of students by area of knowledge Therefore, a data envelopment analysis was performed to measure the efficiency of the inputs and outputs described by the literature; the limitations of the research was circumscribed by the amount of data to be analyzed. As a result, it was identified that the greater the number of features added to the digital platforms, the better levels of participation, attendance and evaluation of students by academic area. Likewise, when considering future lines of research, it is considered ideal to elaborate on the various methods of digital evaluation, such as the digital portfolio and feedback.

Palabras clave
Análisis envolvente; plataformas digitales; educación a distancia; covid-19; México

RESUMEN

Ante la presencia de la pandemia provocada por la covid-19, se implementaron plataformas digitales para continuar con los procesos educativos desde el aislamiento. En el caso de la educación superior y las diversas áreas académicas impartidas, se identificaron diferentes resultados en el uso de las mismas plataformas. En este contexto, se consideró necesario analizar cómo han influido las características tecnológicas implementadas a nivel superior en México en la participación, la asistencia y la evaluación de los alumnos por área académica. Por consiguiente, se realizó un análisis envolvente de datos para medir la eficiencia de las entradas y las salidas descritas por la literatura; las limitaciones de esta investigación se circunscribieron por la cantidad de datos a analizar. Como resultado se identificó que a mayor cantidad de características añadidas a las plataformas digitales hubo mejores niveles de participación, asistencia y evaluación de los estudiantes por área académica. Asimismo, al atender a futuras líneas de investigación, se considera idóneo abundar sobre los diversos métodos de evaluación digital, como el portafolio digital y la retroalimentación.

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INTRODUCTION

This research analyzes the educational platforms implemented during the pandemic caused by covid-19 in Mexico, with the objective of identifying how technological features have influenced the levels of student participation, attendance and evaluation. To this end, the literature is reviewed and fourteen technological features considered important to provide effective services and counteract the effects of the pandemic are identified.

Although digital platforms have proven to be a useful strategy to foster teaching-learning processes, when examining them it is relevant to take the different subjects taught into account; for this paper, nine disciplines or academic areas are analyzed to determine how the platforms influenced the learning process. In this sense, data envelopment analysis is used to build a model that measures efficiency, taking the fourteen characteristics indicated by the literature as inputs, and the participation, attendance and evaluation of students by academic area as output.

The results show the participation, attendance and grading averages, as well as the technological features used and their final efficiency. The findings are described in detail and identify the relationships between inputs and outputs by academic area, where it is found whether the greater the number of features added to the digital platforms, the better the levels of participation, attendance and student evaluation, or vice versa. Finally, the conclusions specify the objective achieved and describe the theoretical and practical contribution found after the research; likewise, the limitations of the analysis are stated and some recommendations for future lines of research are enunciated.

THEORETICAL FRAMEWORK

With the arrival of the pandemic caused by covid-19, which forced the use of information and communication technologies so that education could be developed by digital means (Agamben *et al*., 2020), higher education was forced to design learning structures to teach academic areas digitally, that is, for distance education in the face of isolation (Mejías and Badilla, 2022). The above posed a challenge, since the planning process had to wait, while the reaction was configured as the main exponent of educational policy, which in public policy is considered "getting out of the way" (Aguilar, 1992; 2013). This required the reorganization of educational systems and the transition from face-to-face systems to digital systems in a short time, as well as access to digital competencies in an environment with significant connectivity gaps (Chanto and Loáiciga, 2022).

Due to the above, and with the intention of providing effective services, the United Nations (UN) recommended implementing open source

technologies, so that public education would not depend on digital platforms of private companies (UN, 2020, p. 27); it also called for digital platforms to be portable and to prioritize educational resources and administrative processes, meeting the needs of public education (United Nations Educational, Scientific and Cultural Organization, UNESCO, 2020). These recommendations have had an impact on higher education institutions, where digital platforms administered by universities predominate (Coria and Monge, 2022).

The first actions to counteract the effects of the pandemic were carried out with the implementation of digital platforms, which have added different elements to improve remote learning (Deeley, 2018). An example of this is the introduction of libraries to the digital era, where scientific documents are socialized by network for free and are used as a cognitive tool to develop learning (Carrillo & Flores, 2020). For its part, the production of academic content transitions from a stationary screen (for example, PDF documents as learning didactics) to multimedia elements with expanded and liquid screens (Pardo & Cabo, 2020) or interactive devices that form participatory students.

Also noteworthy are videoconferences, which began as a means of interaction between teacher and student (Wong, 2020). However, experience has shown that videoconference classes should be accompanied by online forums to share narratives that improve students' skills (Wong, 2020), pre-recorded theoretical sessions and synchronous mentoring to strengthen theoretical education (Carrillo & Flores, 2020), since long videos, without additional resources, are equivalent to short attention spans (Pardo & Cabo, 2020).

In this regard, it is important that digital platforms be accessible to students with visual or hearing disabilities (Moreno, 2020) -which should generate technological support products, such as the possibility of automatically creating subtitles or the read-aloud function-, that they be compatible with all browsers, that they prevent plagiarism or identity replacement by students, and that they recognize patterns or even identify individuals at risk of failing or losing the year; these features would facilitate the use of such tools in the teaching-learning process for both teachers and students (Pardo and Cabo, 2020; Portillo *et al*., 2020).

Using digital platforms has proven to be a useful strategy when it generates digital didactic techniques and is conceived as a means of communication between teacher and student (Almazán and Cárdenas, 2012), which allowed the transition from a single model, during the peaks of the pandemic, to the different hybrid models.

It is important to remember that different academic areas require different ways of teaching learning. Likewise, the profiles of students in distance mode define the degree of mastery of learning tools and strategies and,

therefore, the educational didactics to be implemented (Almazán and Cárdenas, 2012); that is, it implies using specific learning theories to improve online university education and that the subjects of learning (teacher and student) connect efficiently through these digital media (Andersen and West, 2020).

This situation can be observed in the improvement of the evaluation process, which went through from sending assignments to the professor by email, with the professional challenges that this implied (Carrillo & Flores, 2020), to the creation of digital portfolios as a learning evaluation strategy, which generated better learning levels and allowed feedback to reconstruct knowledge (Marinho *et al.*, 2021). Although this transformation is complex, it is essential for assessment processes (Henderson *et al.*, 2019).

It is necessary to consider that assessing students is not the only indicator of learning, since not only the learning of content is assessed through a traditional exam, it is also recommended to measure participation and for this purpose self-evaluation, peer evaluation or shared evaluation through discussion forums or question and answer exercises are used (San Martín *et al.*, 2016). Evaluation allows for a series of tests that reflect the learning process of the student (Area-Moreira *et al.*, 2021), in this sense, it is necessary to highlight the importance of the evaluation scheme, which is also conditioned to the type of academic discipline, since sometimes the final exam has greater importance (for example, public universities still consider the final exam as the traditional model of assessment; San Martín *et al.*, 2016), while at other times laboratory practices are more relevant (San Martín *et al.*, 2016). Assessing expected learning is multidimensional and implies implementing different tests, bearing the academic area and the type of university in mind, without forgetting that it is recommended that any evaluation model be accompanied by timely feedback (Carrasco *et al.*, 2021).

Educational platforms must be able to provide spaces to develop skills of flexibility, resilience and foresight in different academic areas, whether exact sciences or humanities (Jordan *et al.*, 2021), where it is possible to generate variations in terms of the responses that were applied to counteract the problem. Herein lies the importance of knowing how these tools influence the learning process, especially when the type of digital platform configures the medium in which the teacher and the student meet, which affects participation, attendance and evaluation results (Ramirez and Barajas, 2017). Specifically, in Mexico the Political Constitution of the United Mexican States (CPEUM, by its acronym in Spanish) establishes that higher or university education enjoys autonomy in the budgetary and academic components (2021, Article 3, Section VII), which allows them to operate attending to a specific situation, this enables the collection of diverse experiences and attends to the theorists of the organizations, in addition it is assumed that by being empowered for

decision making within the institution itself, greater degrees of efficiency are accessed (Bracho, 2011).

METHODOLOGY

This paper aims to identify whether the use of digital platforms, which incorporate the characteristics described above in their implementation, lead to better levels of student participation, attendance and evaluation. To test this hypothesis, the information is subjected to a data envelopment analysis (DEA), considering the products used and the achievements obtained (Chávez *et al.*, 2016; Torres Hernández *et al.*, 2010).

DEA performs a nonparametric, quantitative, technical efficiency study (Miriam *et al.*, 2017) that combines inputs and outputs; it has been used to study efficiency in the educational sector, specifically in higher education (Alfonso *et al.*, 2013), where there are multiple inputs and outputs that can be expressed in units of measurement (Villarreal & Tohmé, 2017). DEA is based on mathematical analysis, it can compare a group of units by level of efficiency and, with this, classify them objectively for decision-making; when the results are obtained, a calculation is performed that gives a score for each unit. This type of study has some limitations, such as sensitivity to data errors (Ramírez and Alfaro, 2013).

For this analysis, fourteen characteristics indicated by the literature were taken as input variables, understood as the quality of the digital infrastructure, or digital platform structure, taking into account the academic program or academic discipline to be taught (Alfonso *et al.*, 2013); as outputs, student performance was evaluated, according to participation, attendance and student evaluation, which implies identifying the use of the resources used to express them in relative efficiency, where values equal to 1 are called: efficient (Quesada-Ibargüen, 2003).

Therefore, the methodology of data envelopment analysis was considered the most appropriate for testing whether the hypothesis is true: the greater the number of features added to digital platforms, the better the levels of participation, attendance and evaluation of students.

Research design

Universe

In order to analyze how the educational platforms implemented at the higher education level in Mexico have influenced during the pandemic caused by covid-19, through the National Platform for Transparency and Access to Public Information (PNT, by its acronym in Spanish) 338 higher education institutions (in its components of autonomous, state,

polytechnic, intercultural technological and pedagogical universities) were requested information about:

Inputs:

Whether the online educational platform implemented by the university during the pandemic:

1) Has a library to provide effective services to teachers and students.

2) Allows the production of academic content by the teacher.

3) Generates videoconferences between the teacher and the student.

4) Has a section for submitting homework assignments

5) Has a section to motivate discussion forums.

6) Has a digital portfolio as a learning evaluation strategy.

7) Has a section for remote feedback.

8) Allows the implementation of pre-recorded theoretical sessions by the teacher.

9) Allows the implementation of synchronous mentoring

10) Is accessible for students with visual or hearing impairment.

11) Avoids plagiarism or identity replacement by students.

12) Is compatible with all browsers

13) Is capable of recognizing patterns or even identifying people at risk of failing or losing the year.

14) Provides remote help for the use of the platform to teachers and students.

The above serves to analyze how the features of the platform have influenced:

Outputs:

1) Participation

2) Attendance

3) Student evaluation

The entire universe considered was nine academic disciplines (in 338 higher education institutions) that receive federal or state resources, which is why they were added to the PNT as obligated subjects. These higher education institutions were sent a request for access to information to provide data regarding the inputs and outputs under study, limiting the research to the academic period from March 1, 2020 to July 9, 2021. The sample (see Table 1) was formed according to the answers given by the higher education institutions, especially those which in the request:

1) Considering technological inputs or features, their response - whether counted, not counted, partially counted - could be normalized into numerical values.

2) Taking into account that in universities, professors enjoy academic freedom, which allows them access to various forms of grading, as well as to determine participation and attendance according to their way of performing assessment, the sample outputs focused on using only those answers that referred to follow a scale of:

(a) Participation: evaluated on a scale of 0 to 100%.

b) Attendance: evaluated on a scale from 0 to 100%; c) Grading: evaluated on a scale from 0 to 100%.

c) Grading: evaluated on a scale of 0 to 10%.

This was done so that the data would be uniform and, in that sense, could be considered as feasible for analysis, especially because to analyze by means of DEA it is required that the data to be analyzed be homogeneous for comparison, and at the same time heterogeneous to extract information after comparing (Pino-Mejías *et al.*, 2010). This is why, considering the nine academic disciplines and the result of the subset of data that makes up the sample, a sample and the input and output values are obtained.

Sample

After receiving the information and processing it, the sample shown in Table 1 was obtained. From this sample the inputs and outputs, or products used and achievements, were measured to obtain the averages.

Table 1. Muestra

Discipline	Higher education institutions studied by discipline
Arts, design and architecture	
Social sciences, humanities and law	
Health, infirmary, optometry, sports and nutrition	
Agronomy and zootechny	
Physics and mathematics	
Chemistry, biology and sea science	
Economic-administrative and tourism	
Engineering and informatics	
Pedagogy, psychology and communication	

Input values

For the inputs, the values were defined on a scale of:

• Has any of the characteristics referred to: 1 point per characteristic.

• Partially has any of the characteristics: 0.5 points per characteristic

• Does not have any of the referred characteristics: 0 points per characteristic.

The following formula was applied to analyze the inputs (see table 2):

Table 2. Input formulas

Formula 1. Efficiency of entries	Average of technological characteristics
E= Entries nE= Amount of entries or technological characteristics that the higher education institution counts with, per academic discipline maxnE = Top value of the total number of considered entries	XE= Average of entries E = Total amount of entries from all the higher education institution per academic discipline n= Amount o higher education institutions studied per discipline

Source: Adapted from Chávez *et al.* (2016), Torres Hernandez *et al.* (2010).

Output values

For the outputs, the values are defined as shown in Table 3. In this sense, the total efficiency, by observing the values of the inputs (result of formula 1, see table 2) and the outputs (result of formula 5, see table 3), is calculated according to formula 6 (see table 4).

The results (, and) are disaggregated by institution, grouped by academic discipline, i.e., the results by higher education institution are shown on the abscissae of graphs 1 to 9. As for the averages, they are described in the text of the section on results by discipline, the formulas are broken down in tables 2, 3 and 4 and the results in table 5.

Table 3. Output forumulas

P = Participation PP = Participation percentage per higher education institution and per academic discipline maxPP= Top value of participation percentage	A = Attendance Pa = Attendance percentage per higher education institution and per academic discipline maxPa= Top value of attendance percentage	C= Grade C = Grade per higher education institution and per academic discipline maxC= Top grade value
Through considering three outputs: participation, attendance and grades, it is measured in the following way		

S= Output. P = Participation. A= Attendance. C = Grade. N= Total amount of entries		
Average value per academic area or academic discipline		
XP= Average of participation EP= Total amount of participation from al the higher education institution per discipline N= Total amount of higher education institutions studied per discipline	XA= Average of attendance EA= Total amount of attendance from al the higher education institution per discipline N= Total amount of higher education institutions studied per discipline	XC= Average of grades EC= Total amount of grades from all the higher education institution per discipline N= Total amount of higher education institutions studied per discipline

Source: Adapted from Chávez *et al.* (2016), Torres Hernandez *et al.* (2010).

Table 4. Efficiency formula

Formula 6. Total efficiency	Efficiency average
Ef= Efficiency S= Outputs E= Inputs	XEf= Average of entries EEf= Total amount of entries from all the higher education institution and per discipline N= Total amount of higher education institutions studied per discipline

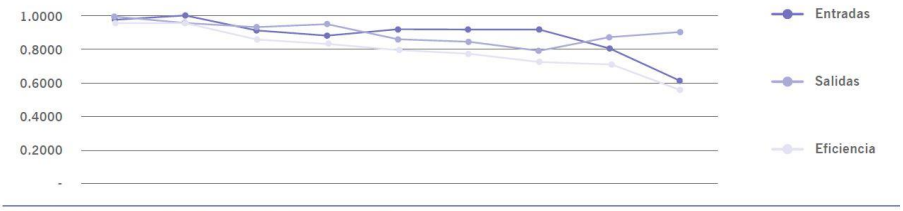
Source: Adapted from Chávez *et al.* (2016), Torres Hernandez *et al.* (2010).

RESULTS

Arts, design and architecture

Nine institutions of higher education were analyzed in their technological university component. When extracting the data, where values close to 1 are the most efficient, three important elements were identified: inputs (E), outputs (S) and efficiency (Ef). Figure 1 shows the direct relationship between the variables considered in this study by institution. In relation to the averages by group of disciplines, the average of technological

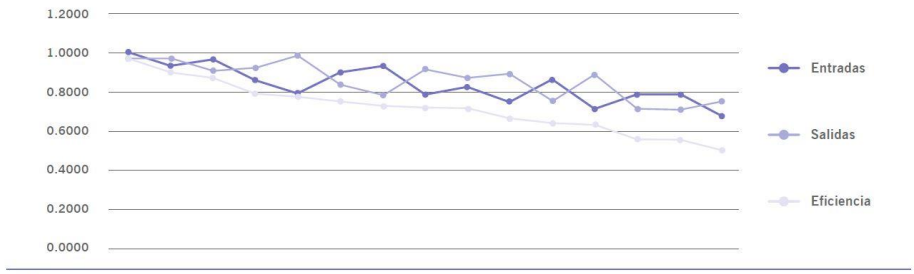
characteristics used in the platforms is 11.5 $\left(\overline{X}E = \frac{\Sigma E}{n}\right)$, the average of participation in the platform is 93.03 $\left(\overline{X}P = \frac{\Sigma P}{n}\right)$, the average of attendance is 89.43 $\left(\overline{X}A = \frac{\Sigma A}{n}\right)$ and the average of grades is 8.35 $\left(\overline{X}C = \frac{\Sigma C}{n}\right)$, where the average of efficiency by units studied is 0.79 $\overline{X}Ef = \frac{\Sigma Ef}{n}$.



Gráfica 1. Eficiencia por disciplina de Artes, diseño y arquitectura.
Fuente: elaboración propia con información de la muestra recolectada.
Nota: en las abscisas se reflejan las instituciones.

Social sciences, humanities and law

Fifteen higher education institutions were researched in their state, technological and intercultural university components. With respect to the values close to 1 in the relationship between inputs, outputs and efficiency, Graph 2 shows the link between the variables studied, where variations are observed between inputs or outputs that have an impact on efficiency. When analyzing the data, variations arise in student performance defined by the outputs of participation, attendance and evaluations.



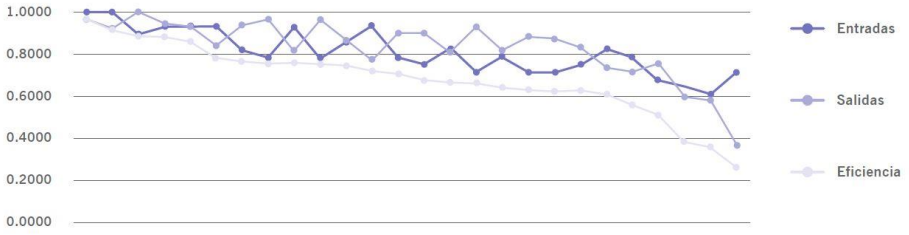
Gráfica 2. Eficiencia por disciplina de Ciencias sociales, humanidades y derecho.
Fuente: elaboración propia con información de la muestra recolectada.
Nota: en las abscisas se reflejan las instituciones.

For the disciplines of Social Sciences, Humanities and Law the average participation was 84.60, for attendance it was 82.74 and for grades 8.48. As regards the average of the technological characteristics of the platforms implemented during the pandemic, the result was 11.70, while in the final efficiency a value of 0.71 was obtained.

Health, Nursing, Optometry, Sports and Nutrition

The results of this academic area are made up of 26 institutions of higher education in its components of state, technological, polytechnic, autonomous and intercultural universities. When analyzing the inputs,

outputs and efficiency with a value close to 1, it is shown that the data, although homogeneous among themselves, have important variations, since the output variables begin to keep a downward symmetry, where the average of technological characteristics decreases; the same happens with the outputs of participation and attendance (see figure 3).

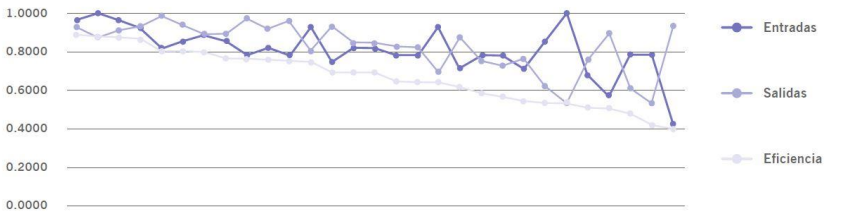


Gráfica 3. Eficiencia por disciplina de Salud, enfermería, optometría, deporte y nutrición.
Fuente: elaboración propia con información de la muestra recolectada.
Nota: en las abscisas se reflejan las instituciones.

The average for this academic area under study, in terms of input variable is 11.30 and in terms of participation it is 79.44, the average attendance is 79.38 and in terms of grades it is 8.49; likewise, the average efficiency value is 0.68. The results show how decreasing the technological characteristics used directly reduces the outputs, specifically participation and attendance, although the grades remain the same.

Agronomy and animal husbandry

This area has a sample of 29 higher education, technological, state, polytechnic and intercultural institutions. The trend in terms of the characteristics used by the platforms and the results of participation, attendance and evaluation is that they are no longer homogeneous and are again decreasing, since there are values per institution close to 1 in the inputs, with output values of 0.50 (see figure 4).



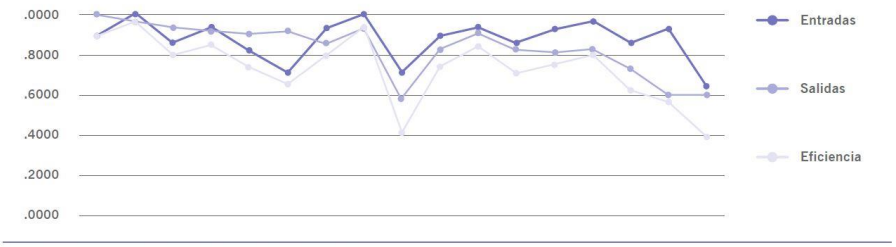
Gráfica 4. Eficiencia por disciplina de Agronomía y zootecnia.
Fuente: elaboración propia con información de la muestra recolectada.
Nota: en las abscisas se reflejan las instituciones.

In this case, the average participation rate is 79.96, the average attendance rate is 76.91 and for the grades it is 8.24; in relation to the number of technological characteristics of the platforms, the average is 11.39 and the average efficiency is 0.67. Once again, it can be seen that the lower the

number of technological features used, the lower the average participation and attendance.

Physics-mathematics

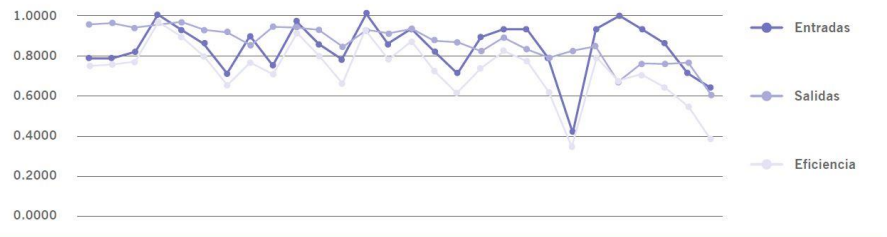
A sample of 17 institutions at higher levels of competence, polytechnic, technological and autonomous was taken for the study. The results show that the higher the technological characteristics employed, the higher the degrees of participation, attendance and grades. Graph 5 shows variations among the inputs. Regarding the inputs, the study of this academic area has an average of 12.23 elements considered in the total sample, a participation of 83.04, an attendance of 80.69 and an average grade of 8.28, the efficiency as an average value obtained is 0.73.



Gráfica 5. Eficiencia por disciplina de Físico-matemática.
Fuente: elaboración propia con información de la muestra recolectada.
Nota: en las abscisas se reflejan las instituciones.

Chemistry, biology and marine sciences

The sample is made up of 28 institutions at the higher level in its components of technological, state, polytechnic and autonomous universities. This discipline has an average number of technological characteristics employed of 11.75, an average participation of 86.04, attendance of 82.89 and grades of 8.38, the efficiency value is 0.72 on average. The results show homogeneous values between inputs and efficiency, with some variations in relation to outputs. When analyzing only the outputs, there is a direct relationship between the technological characteristics and the degrees of participation and attendance, with small variations in the grades (see Graph 6).

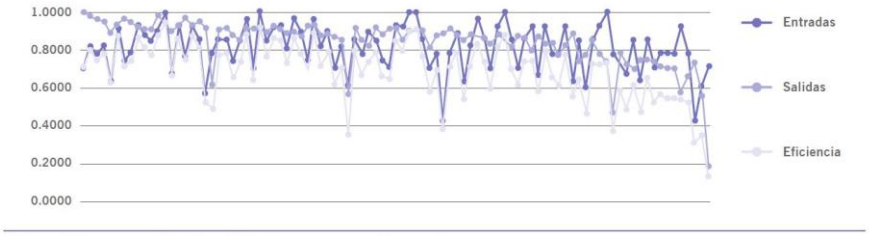


Gráfica 6. Eficiencia por disciplina de Química, biología y ciencias del mar.
Fuente: elaboración propia con información de la muestra recolectada.
Nota: en las abscisas se reflejan las instituciones.

Economic-administrative and tourism

This academic area has the second largest sample, with 93 institutions of higher education in its components of technological, polytechnic, intercultural, autonomous and state universities (see Figure 7).

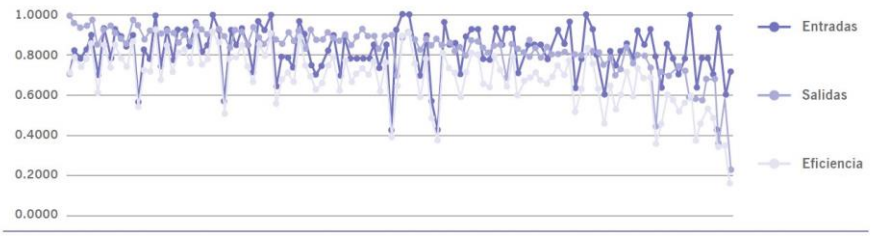
The results for this area show how the structure of the platforms as an input variable generates significant outputs (participation, attendance and evaluation), i.e., better performance. For this case the average input is 11.44 and the average output corresponding to participation is 85.14, the average attendance is 84.14, for grades 8.5, as well as an average efficiency of 0.69.



Gráfica 7. Eficiencia por disciplina de Económico-administrativas y turismo.
Fuente: elaboración propia con información de la muestra recolectada.
Nota: en las abscisas se reflejan las instituciones.

Engineering and computer science

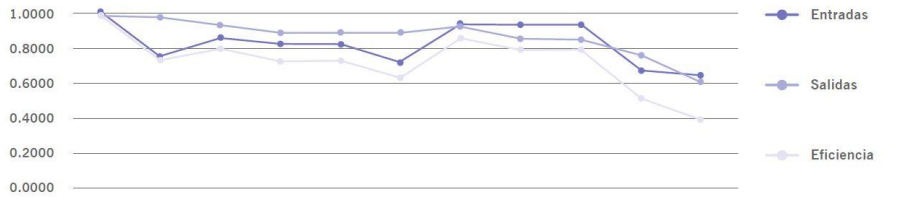
The sample concerning the discipline of Engineering and Computer Science is 116 institutions of higher education and includes technological, polytechnic, state and autonomous universities. The results are shown in Figure 8. In this case there is a significant relationship between the input and output values analyzed: best platforms, best participation, attendance and grade point average. In this academic area the overall average is as follows: participation 84.90, attendance 82.40, grades 8.2 and characteristics of the educational platform 11.53; the efficiency value on average is 0.68.



Gráfica 8. Eficiencia por disciplina de Ingeniería e informática.
Fuente: elaboración propia con información de la muestra recolectada.
Nota: en las abscisas se reflejan las instituciones.

Pedagogy, psychology and communication

The last academic area to be studied is Pedagogy, psychology and communication, with a sample of eleven institutions of higher education in its components of technological, pedagogical, state and intercultural universities. Figure 9 shows the relationships in which the general average of participation is 82.45, for attendance it is 87.62, the average of grades is 8.95 and they use on average 11.54 of the technological characteristics considered; the most efficient value is 0.72.



Gráfica 9. Eficiencia por disciplina de Pedagogía, psicología y comunicación.
Fuente: elaboración propia con información de la muestra recolectada.
Nota: en las abscisas se reflejan las instituciones.

It stands out that in all cases there is a low implementation of digital libraries within the platforms, low accessibility for students with disabilities, low capacity to recognize patterns, absence of elements to avoid plagiarism or identity replacement, as well as few digital spaces for synchronous mentoring and remote feedback. The total values are broken down in Table 5.

Tabla 5. Resultados finales

Disciplina	Promedio de participación	Promedio de asistencia	Promedio de calificaciones	Promedio de características tecnológicas	Promedio de eficiencia
	$\overline{X}P = \Sigma P/n$	$\overline{X}P = \Sigma A/n$	$\overline{X}P = \Sigma C/n$	$\overline{X}E = \Sigma E/n$	$\overline{X}Ef = \Sigma Ef/n$
Artes, diseño y arquitectura	93.03	89.43	8.35	11.50	0.79
Ciencias sociales, humanidades y derecho	84.60	82.74	8.48	11.70	0.71
Salud, enfermería, optometría, deporte y nutrición	79.44	79.38	8.49	11.30	0.68
Agronomía y zootecnia	79.96	76.91	8.24	11.39	0.67
Físico-matemáticas	83.04	80.69	8.28	12.23	0.73
Química, biología y ciencias del mar	86.04	82.40	8.38	11.75	0.72
Económico-administrativas y turismo	85.14	84.14	8.50	11.44	0.69
Ingeniería e informática	84.90	82.40	8.20	11.53	0.68
Pedagogía, psicología y comunicación	82.42	81.05	8.68	11.54	0.72

Fuente: elaboración propia con información de la muestra recolectada.

Findings

In relation to the variables studied in their input and output components, the following is noted:

1) Higher technological characteristics, higher levels of attendance and participation, where values equal to or greater than 11.40 achieve an average greater than 80% attendance and participation.

2) Fewer technological characteristics, lower levels of attendance and participation, where values of 11.30 reflect an average attendance and participation of less than 80%.

3) It can be affirmed that the number of technological characteristics of the platforms has a direct influence on the average attendance and participation.

4) The technological characteristics of the platforms do not directly influence the average grades per discipline, since it was identified that:

a) The area of Physics-mathematics has the highest average of technological inputs or characteristics, and has the third lowest average of grades.

b) Health, nursing, optometry, sports and nutrition have the lowest average number of entries and the third highest grade point average.

5) The disciplines of Health, nursing, optometry, sports and nutrition, as well as Agronomy and zootechnics, have similar variations, with averages lower than 80% in participation and attendance, and grades with values higher than 80%, which implies that for these disciplines participation and attendance do not have a direct influence on the grade.

6) The highest degree of efficiency is reached by the disciplines of Arts, design and architecture, with the best attendance and participation averages, and with the second lowest average.

7) The lowest degree of efficiency is obtained by Agronomy and zootechnics, with the lowest average of attendance and participation.

8) The disciplines of Arts, design and architecture, Social sciences, humanities and law, Chemistry, biology and marine sciences, Economic-administrative and tourism, Engineering and computer science, as well as Pedagogy, psychology and communication, confirm the hypothesis that the more features added to the digital platforms, the better the levels of participation, attendance and evaluation of students.

9) The disciplines of health, nursing, optometry, sports and nutrition, agronomy and zootechnics, as well as physics-mathematics, reject the proposed hypothesis.

CONCLUSIONS

By means of a DEA, in this research we were able to measure the efficiency of educational platforms at the higher education level in Mexico by academic area during the pandemic caused by covid-19. The averages of participation, attendance, qualification and technological characteristics were obtained, as well as efficiency results by academic discipline, which allowed us to identify in which academic area the hypothesis that the greater the number of features added to digital platforms, the better the levels of student performance (finding 8) and in which cases this relationship is rejected (finding 9).

Regarding the theoretical and practical contribution, the literature studied allowed identifying how digital platforms promote the production of academic content and serve as migration instruments to provide effective services to teachers and students, for example: videoconferences, forum for doubts, spaces for sending assignments, digital portfolio, remote feedback, pre-recorded theoretical sessions by the teacher and synchronous mentoring, which encourages participation, attendance and evaluation of students. The methodology consisted of a mathematical model adjusted to the theory studied, which measures various inputs and outputs.

Regarding the limitations of the research, it was limited by the amount of data to be analyzed, since, although 338 institutions of higher education were asked for information related to the variables studied, not all of them responded, in addition to the fact that each university, according to the characteristics of the discipline to be taught, uses different means of evaluation, so that the output variables were considered only according to the evaluation scale used. Finally, and taking account future lines of research into account, we recommend to analyze the various digital assessment methods: digital portfolio and feedback, to include them as output variables by virtue of the digital platform-grading relationship.

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