Use of Data Mining to Identify the Preferences of students of the Autonomous University of Aguascalientes regarding extracurricular courses through Data storytelling for course management and planning

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Abstract

Humanistic courses are a requirement of the Autonomous University of Aguascalientes for all its students, who must take at least three courses from different disciplines during their career to graduate. The courses offered are a way in which students from different careers can relate to each other, and in this way, develop comprehensively. These courses are offered year after year with minimal change as to which courses and at what times they are offered. The studies regarding the real demand of the students are almost non-existent, and for the same reason the courses offered do not always serve to meet the demand of the students, who find themselves in the need to take courses that they normally do not attend. would sign up to meet the requirements. In addition to the needs of the students, the problem of course management arises, where a process is carried out for the registration of courses to be offered, and their publication.It is examining the potential of data storytelling through a review of the literature and presentation of case studies, it will be explored how data storytelling can help in the administrative activities for analyze and present data effectively, for the informed decision making.

Keywords: Courses Management, Schedule, Data mining, Data Storytelling.

1 Introduction

For years the Autonomous University of Aguascalientes has aimed to create professionals with comprehensive training in all aspects of their life, which is why it has insisted that its students take courses outside their area and with students from other careers. so that in this way they have knowledge in other areas and meet people from other careers with interests in common with them. This is why the University made the decision to create humanistic training courses, which are a set of courses that seek to expand the knowledge of university students in areas that are not normally studied in their careers but that are of interest. of some students.

Every year a considerable number of courses are opened in two modalities, intensive courses, which are opened in inter-semester periods for three weeks, and extensive courses, which are courses that cover the entire semester. The investment made to be able to have this offer is too great, from hiring teachers for each course to the materials consumed during them. The courses that are opened year after year vary very little, since the study plans or the courses to be taught are rarely radically modified; This is done with little or no consideration of the general opinion of the university community, since despite the demand that this generates, the courses remain static in terms of supply. This generates a large number of problems, since many courses are offered that are only filled with students who enter only to meet the university's requirements and not because they would really like to take the course; On the other hand, there are courses that have excessive demand and of which only one or two groups are opened per period, regardless of the fact that there are a large number of students who are left out of said courses due to lack of places to take them.

It is for this reason that the decision was made to carry out a study, through surveys of current students at the university, about which courses they would really like to take, at what times and in what modality of those offered. This is with the intention of analyzing whether the courses that are opened efficiently satisfy the demand of the student community, as well as to see which are the courses that are really demanded by the students, which are those that are opened unnecessarily, and which are They are the ones who should expand their offer. Everything is done with the aim of the university improving the current offer of humanistic training courses so that it really satisfies the demand of the students, and that this requirement really meets the purpose for which it was created.

Teaching planning is considered a fundamental and indispensable element for the teacher to fulfill his mission as a mediator, facilitator and expert of the educational process. In teaching practice, class planning becomes a primary activity since it is considered the turning point to achieve the objective of the teaching-learning process, since planning is carried out considering the needs of all students [1]. Taking the same principle of class planning, in the area of university extension work is done to manage and plan courses to offer to students, extending the planning activity to a higher degree of complexity, due to the number of courses and students. that are required, becoming a very difficult administrative task, which is why we seek to facilitate and improve said process.

Considering the findings mentioned above, the objective of this work is to propose and evaluate the use of data storytelling by instructors to observe areas of improvement opportunities in the courses, identifying course preferences by students; allowing them to plan and manage their courses in a simpler way and that contributes to facilitating and optimizing the process of managing extracurricular courses.

2 Related Work

The organization and search of metadata using developed software or specialized software such as Weka is in constant development due to the growing demand for data to be processed, which is why more precise and advanced approaches are increasingly required for the efficient management of the data. information [2,3,4].

Regarding data search, many algorithms have been proposed that allow for agile queries of large data sets. The improvement in search speed, as well as in obtaining information, is thanks to indices that have been developed as B, B+ trees or hash tables, which are types of structures through which data is represented in an orderly manner that allows insertions. and efficient deletions thereof [5]. In the search and organization of data, the implementation of metadata is of utmost relevance, since these provide very important information such as origin, creation dates, formats, etc. Which allows the precision and efficiency of searches to increase [6].

The state of the art is constantly evolving because, as mentioned in previous points, the data handled is increasing exponentially, which is why the development of increasingly sophisticated, precise, agile and optimized algorithms is promoted. [4].

Currently, no field study has been carried out regarding the humanistic courses at the Autonomous University of Aguascalientes, the few modifications that are made in the study plans or in their offer are based solely on the registrations that are made during the previous periods. This is one of the worst ways to carry out this analysis, since many students enter courses in which they have no interest, but still enroll to fulfill the course requirements; this results in an inefficient course offering for the university community.

2.1 Assignment of Schedule Problem

The assignment of schedules problem is a recurrent situation in all educational institutions [7], where the schedule of the students is planned, assigning signatures, classrooms, and teachers, with the objective of avoiding an overlap of hours. It corresponds to optimization problems in computational complexity theory classified as NP-complete problems or NP-hard problems [8], due to its complexity, resource limitations and number of restrictions. These problems requiring the entry of applications with intelligent algorithms [9].

2.2 Weka

Weka is a software tool widely used in the field of data mining and machine learning. Weka, named after "Waikato Environment for Knowledge Analysis", was developed at the University of Waikato in New Zealand [10]. Weka provides a collection of machine learning algorithms for classification, regression, clustering, and rule extraction tasks. Additionally, it includes tools for data preprocessing, model evaluation, visualization, and data exploration.

2.3 Data Science: Algorithmic

Within data science we have different techniques for data processing, such as classification, clustering and prediction algorithms, with the option of being able to combine algorithms with each other to obtain a better result.; however regardless of the approach taken for it, asides from the requirements of implementation to cover and the selection criteria according to the problem to solve it is important to identify beforehand the area of implementation and the intrinsic characteristics that it will provide.[11]
Within the renowned areas of computer science to cover the demands of the society the branches of Artificial Intelligence and Data Science provide the basis for the development of modern technologies and data driven based solutions [12,13].

The following table shows the algorithmic techniques taken into consideration [14, 15, 16, 17], the model they are part of, a brief description, and remarks of the thought process regarding the selection of the supervised learning model and the unsupervised model

Table 1: Algorithmic techniques

Learning	Model	Description	Remarks
Supervised	Decision Tree	Weighted decision trees	Use the principle of Shannon's information theory.
Supervised	Random Forests	Group of trees with characteristics.	High accuracy and training complexity. They usually use the result of the decision trees for the input of the next tree.
Unsupervised	Expectation Maximization algorithm (EM)	Iterative method for maximum likelihood estimation of parameters.	Ensures convergence of the likelihood function. Helps when variables are missing and in poorly conditioned problems.
Unsupervised	K-means	Grouping by distance between data.	Mainly the Euclidean distance is used to obtain the clusters by characteristics.
Unsupervised	Hierarchical Clustering	Create ascending or descending group hierarchy.	Generally, uses a greedy algorithm.
Unsupervised	Gaussian Mixture Models	Probabilistic model that representing normally distributed data.	Suffers in data scalability, making it unsuitable for large data sets.

2.3 Data Storytelling

For data management and knowledge discovery, data science is currently used in companies to obtain a competitive advantage, while the set of artificial intelligence algorithms, data science methods and business intelligence practices complement each other to improve the management and analysis of information in what we know as data storytelling.

Data storytelling is used to obtain data analysis in a simple way by implementing data visualization, dashboards and objectives, which allows its use to be extended to other areas of knowledge and not limit its use in companies for decision-making or commercial actions. One of these examples is the one shown in storytelling work and inverted learning to strengthen mental health. in teachers within the school in post-pandemic contexts due to COVID 19 [18] where they use data storytelling to design strategies together with flipped learning to strengthen the mental

health of teachers, who suffered from psychological consequences due to the abrupt change of the transition from in-person to virtuality.

Another of the works is the one presented in: “Digital storytelling as a pedagogical tool for the teacher in the teaching-learning process of preschool students in the coastal region of Oaxaca”[19], where they analyze the use of storytelling in the teaching-learning process, where the teachers themselves mention that by applying this tool they obtain greater benefits for both themselves and the students, even when the teachers were not instructed to use similar tools, allowing them to carry out the tasks. administrative in a more efficient way.

While the work “Storytelling with learner data: guiding student reflection on multimodal team data” [20], mentions the growing interest in creating interfaces with learning analysis feedback to help students, which, although with a lot of use not many of them provide meaningful information. Therefore, the work shows the evaluation of a work analysis tool in clinical simulations, this tool helps students see their errors or incidents that occurred during the simulation, through the application of data narration. This allows students to identify misconceptions and errors; think about strategies they could use to avoid such errors and for teachers provides information on formative assessment along with learning analytics. After providing feedback to students, teachers also obtain visual feedback through dashboards that allow them to locate objectives more quickly and obtain the history of their students to be able to make more accurate and simple decisions, which Help in administrative processes for planning and management.

We can see another example of the use of data storytelling at work.: “ Towards data storytelling to support teaching and learning”[21], where they mention improvements that can be made in the data visualizations, to be able to assertively communicate the information to users, understanding the contribution that each visual element makes to the narration of the data and the effectiveness of the improvements, commenting on their results that the fundamental elements in the visualization add clarity when there are multiple stories, allowing to focus objectives and simplifying the visualization through eye-catching elements.

In summary, the use of data storytelling in education has proven to be an effective tool to improve learning, development of students' skills and knowledge, as well as helping teachers in their teaching-learning process activities and administrative activities, allowing optimizing times and facilitating decision making. Various studies have implemented data narrative, focusing the objectives on special markers to make the most of data visualization, allowing the teacher to have a tool that facilitates data analysis in the teaching-learning process, management and planning of administrative activities.

3 Problem Outline

A valuable tool in the field of data science is Weka software. Weka provides a wide range of machine learning algorithms and tools for data preprocessing and analysis. Its user-friendly environment and extensibility make it a popular choice for researchers and professionals in the field of data mining [22,23]. To begin the study, a survey was first planned that could, with the smallest number of questions, gather the necessary data to know the trends of university students regarding humanistic courses, from which are the most requested to which are the most popular. trends by major and sex for each course.

To carry out this study, 680 surveys were carried out randomly among students from all possible centers and careers to form a statistical sample about which humanistic courses have a real demand. The survey was designed to collect the following types of data:

- Age [18-25]
- Gender [M - F]
- Career [Tipificados]
- Schedule [M - V]
- Course schedule [M V S]
- Course type [I E A]
- Course I would take [Tipificados]

General information about the students is requested, such as age; obtaining a range of between 18 and 25 years among the respondents; sex, career; Students could select from the university's list of majors to avoid a problem in capturing the major's name and a subsequent problem in data cleaning; shift; morning (M) or afternoon (F) according to your class schedule; course schedule; The university offers morning (M), afternoon (V) and Saturday (S) schedules for humanist courses; type of course; Within the courses there is an intensive (I) and extensive (E) modality, so students could select the modality of their preference or both (A); and the course they would take; the list of courses offered by the university is taken.

The surveys were carried out within the university city to cover the current university population. It was sought that most of the students interviewed were within the first semesters of their degrees, thus ensuring that the answers

were as close to reality as possible, since during this period, most students are studying or finishing to complete this requirement.

Once the 680 surveys were completed, the information obtained was cleaned, since there were several entries with missing data, which were filled with the average data, and the information was emptied into a database.

Once the complete database was available, we proceeded to choose which data were necessary and which would only get in the way when carrying out a data mining process; It was determined that the data chosen initially were those necessary to correctly carry out the study that was wanted to be carried out and therefore no fields were eliminated.

The database was then moved to a file with an. arff extension, which briefly described the type of data used and all the instances in the registry.

Using the weka program, the data was analyzed. The knowledge base was clustered using the EM algorithm, because when this procedure was carried out through KMEANS the error obtained was too large, which is why it was determined that the best way to classify this base was through the EM algorithm (Fig. 1).

	Cluster						
Attribute	0	1	2	3	4	5	6
	(0.06)	(0.15)	(0.23)	(0.17)	(0.16)	(0.19)	(0.03)
edad							
mean	20.5308	19.3487	20.2022	19.7162	18.7102	18.3782	20.5129
std. dev.	1.2434	0.491	0.4226	2.001	0.5787	0.4852	0.5043
sexo							
F	1.0025	28.196	37.2628	18.7861	11.288	35.4648	3.9998
M	12.0106	1.048	6.9271	13.2412	19.5721	1.0799	4.1211
[total]	13.0131	29.244	44.1899	32.0273	30.8601	36.5448	8.1209
semestre							
mean	5.7493	3.3118	3.2149	2	2	1.5662	7.9963
std. dev.	2.5013	0.8321	0.4109	1.6187	1.6187	0.4957	0.1226
carrera							
Administracion_de_Empresas	1.0109	1	1	1	1	1	6.9891
Administracion_Financiera	2.0361	1.0087	1	1.1338	2.8168	7.0046	1
Computacion_Inteligente	1.0005	1.9418	1.0009	1.2998	15.508	3.2489	1
Contador_Publico	1	1.0046	1	1.0191	3.9756	10.0007	1
Diseno_de_Modas	1.0001	1.018	18.9817	1	1	1.0001	1.0001
Electronica	6.8891	1.0016	3.9793	1	1	1	1.13
Ensenanza_del_Ingles	1.0002	3.9789	7.0205	1	1	1.0002	1.0001
Estomatologia	1.0002	15.6323	1.016	4.2602	1.0282	1.0631	1
Gestion_Turistica	1.0004	1.0076	1.0008	26.4707	2.8048	3.7157	1
Ingenieria_Bioquimica	1	1.0141	1	1.2258	1.0043	12.7557	1
Letras_Hispanicas	1.0002	3.857	1.0004	1.4044	6.9829	3.7551	1
Mercadotecnia	2.0469	1.0001	1	1.2135	2.7395	1	1
Psicologia	4.0285	6.7792	16.1903	1	1	1.0004	1.0015
[total]	24.0131	40.244	55.1899	43.0273	41.8601	47.5448	19.1209
turno							
0	1.1227	28.2208	43.1372	30.68	26.3038	35.5313	1.0042
1	11.8904	1.0232	1.0527	1.3473	4.5563	1.0135	7.1166
[total]	13.0131	29.244	44.1899	32.0273	30.8601	36.5448	8.1209
horario							
0	1.0263	13.3045	24.7369	2.5024	17.2135	4.2234	6.9931
1	1.0004	4.047	13.0043	13.6116	1.7473	29.5894	1.0001
2	2.0361	6.7894	1.012	1.6366	2.8873	3.6386	1
3	10.9504	7.1031	7.4368	16.2767	11.0119	1.0934	1.1276
[total]	15.0131	31.244	46.1899	34.0273	32.8601	38.5448	10.1209
tipo							
0	6.2007	1.0821	33.8476	17.4742	18.1233	4.265	7.0071
1	3.9231	19.0929	9.831	14.0766	1.1073	26.9677	1.0015

Figure 1: Clustering of analyzed data

After carrying out said clustering, the results were analyzed using the graphs that were shown to us as a result. Of these graphs, there are 3 that attract attention. The first is the one that shows the sex (Y) with respect to the course they choose (X) (Fig 2).

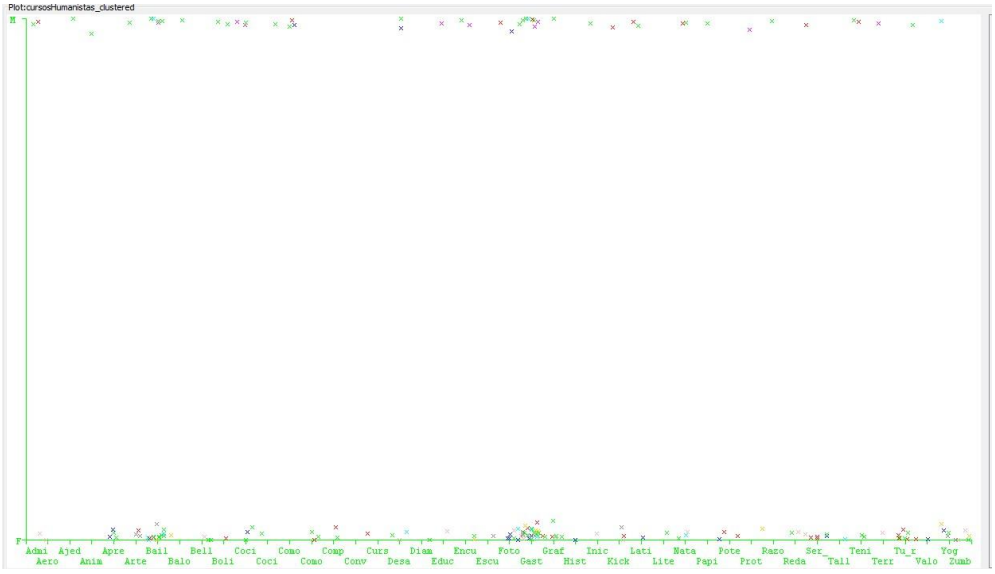


Figure 2: Data visualization of course selection by gender

From this graph it can be determined that the courses: Ballroom Dancing, Photography, Gastronomy, Graphology, Yoga and Zumba, are the focuses of interest for the female population of the University, since it is where about 75% of those interviewed said that I would take one of those courses if possible. On the other hand, men only have a very weak focus of interest in the Gastronomy course, since their population is distributed more homogeneously in all courses, without having much inclination for anyone.
The next graph of interest was the one that shows the career (Y) with respect to the course they choose (X) (Fig. 3)

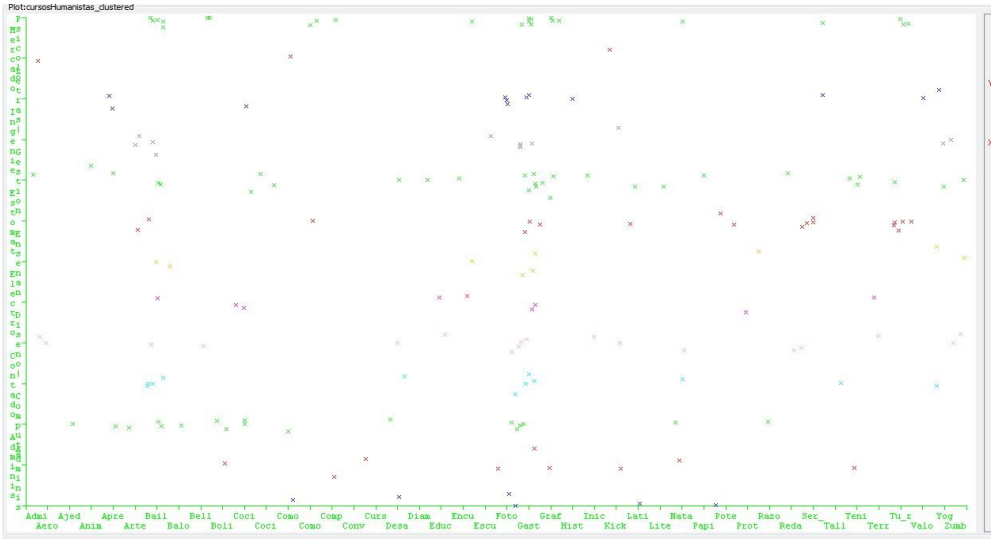


Figure 3: Data visualization of course selection by carrer

In this graph it can be seen that the majors from the Economics and Administration center have a tendency to enter the Gastronomy and Photography courses, while those from the other centers have a greater tendency to enter the Ballroom Dance, Yoga courses. and Zumba.

Finally, the last graph of interest is the graph that shows the type of course (Y) with respect to the course they choose (X).

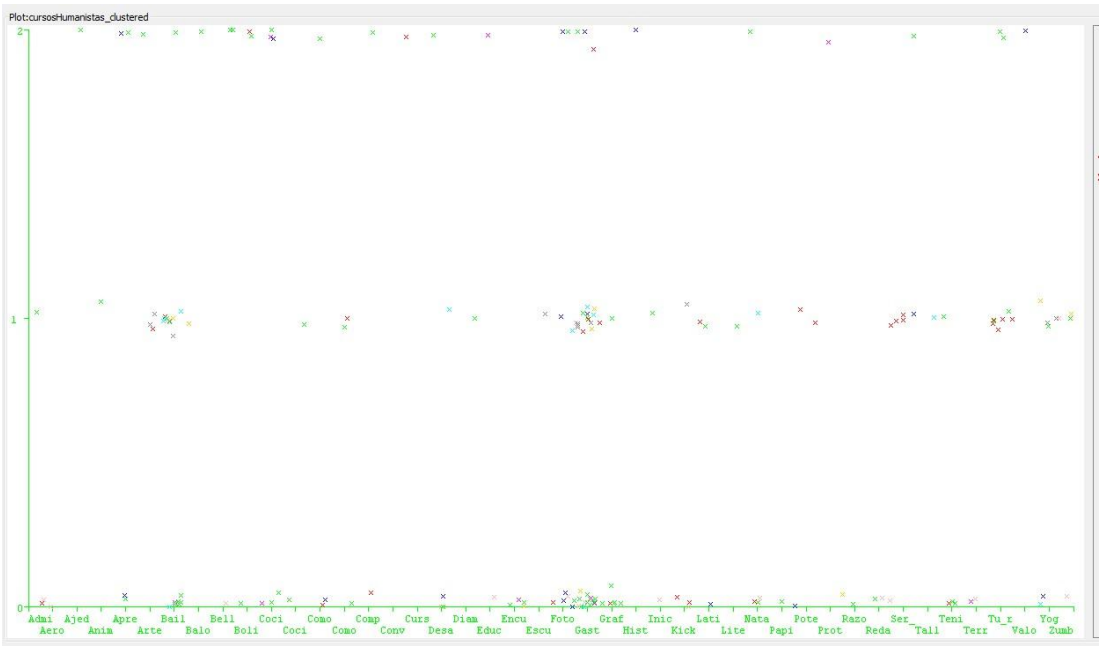


Figure 4: Data visualization of course selection by modality

In this graph you can see how the most requested type of course, for Gastronomy, Ballroom Dancing, Zumba and Yoga, is extensive and not intensive as would have been expected. However, for the other courses, the intensive period is the most requested to carry it out.

4 Model Proposed

This section addresses the model proposal used for the implementation of data storytelling through dashboards in administrative and planning activities, which allow visualization of the sections and important data for the proposal of new groups, course preferences, schedules with greater activity, necessary resources, among others. The main proposal consists of five key components: instructor, students, resources, analysis and dashboards. Each of the components plays a fundamental role in the development of course planning for students. The following figure shows the proposed model, to later describe each of the components.

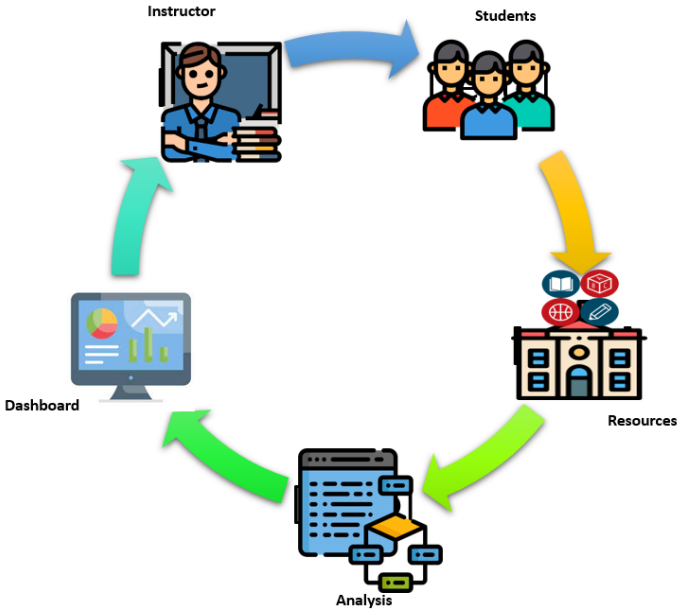


Figure 5: Proposed model for the implementation of data storytelling through dashboards in the planning of humanistic courses

4.1 Instructor

The instructors are the facilitators, mediators and evaluators of the students, they will be in charge of the proposal, impartation and evaluation of courses, they will record the data of the courses and their evaluations to later be able to visualize them through the dashboards and the implementation of data storytelling relevant information for the management of humanistic courses.

4.2 Students

Together with the instructors they are the central axis of the research, the students will use the resources corresponding to the registration course, the course survey and the information provided from the dataset history, at the end of each course the students will carry out a survey that will allow the information to grow of the dataset to strengthen the analysis of information and data storytelling, thus allowing us to obtain more detailed information and subsequently be able to anticipate course planning.

4.3 Resources

Any resource that teachers and students use for the development of the course can include traditional resources (use of blackboard, readings), technological resources (cell phones, tablets, computers) and implementation of new technologies (augmented reality, virtual reality, artificial intelligence) as well as such as the place of delivery (classroom, laboratory, sports area).

4.4 Analysis

They are the instruments and algorithms that will be used to obtain the information necessary for the construction of data storytelling, allowing a prediction to be made about the management and planning of courses. It forms the core of the program considering the data collected from the interviews with the students, the necessary resources and the opening times of the courses, to later display the data in a dashboard that will be viewed by the administrators and through the implementation of data storytelling can easily identify the most relevant information about the courses.

4.5 Dashboard

Information boards that will implement the data narrative, to facilitate data visualization for administrators, presenting in a focused, friendly and simple way the points of special attention of students, instructors and courses, allowing them to identify existing problems that can help the course management and planning.

5 Results

As part of the verification of the prediction about the preference for humanistic courses, surveys were carried out with 680 students at the University, denoting that the initial predictions are correct to be able to be implemented in decision making through data storytelling on the board of the application. According to the results obtained by the people surveyed on the part of instructors and administrators; it can be seen that the dashboards provide them with relevant information for their course management and planning processes.

5.1 Participants or sample

The selection of the sample for this case study was random, taking into account students from different centers, semesters and schedules, trying to cover the various variables that may influence the selection of courses. For instructors and administrators, we have the participation of 20 people, who are involved in the registration process, teaching and proposal of courses at the university.

Table 2: Profile of participants (students)

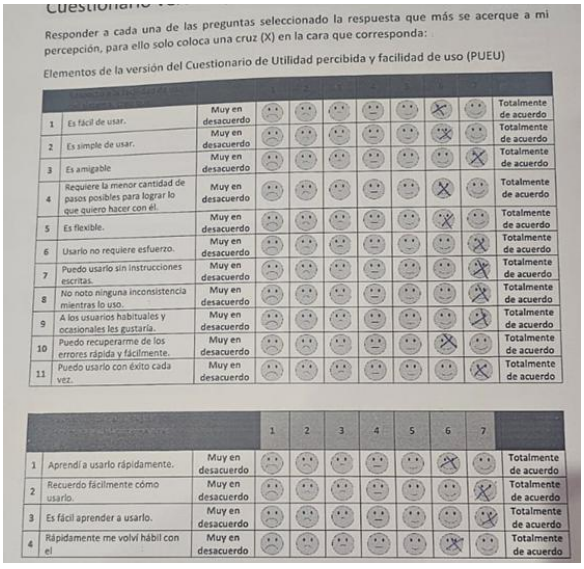
Center	Number os students	Turn	Semesters
Basic sciences	90	Morning	2-8
Business Studies	125	Morning/ Evening	1-7
Social Sciences and Humanities	95	Morning/ Evening	2-6
Economic and Administrative Sciences	135	Morning/ Evening	1-9
Health Sciences	30	Morning	2-5
Design and Construction Sciences	125	Morning/ Evening	2-8

Table 3: Participant profile (instructors and administrators)

Role	Amount	Turn
Instructors	15	Mixed
Administrador	5	Morning/ Evening

5.2 Instruments and tools

A questionnaire with a Likert scale is carried out as a usability test for instructors and administrators to identify the perceived usefulness and ease of use of the dashboards using data storytelling and verify their functionality and usability.


Responder a cada una de las preguntas seleccionado la respuesta que más se acerque a mi percepción, para ello solo coloca una cruz (X) en la cara que corresponda:

Elementos de la versión del Cuestionario de Utilidad percibida y facilidad de uso (PUEU)

1	Es fácil de usar.	Muy en desacuerdo								Totalmente de acuerdo
2	Es simple de usar.	Muy en desacuerdo								Totalmente de acuerdo
3	Es amigable	Muy en desacuerdo								Totalmente de acuerdo
4	Requiere la menor cantidad de pasos posibles para lograr lo que quiero hacer con él.	Muy en desacuerdo								Totalmente de acuerdo
5	Es flexible.	Muy en desacuerdo								Totalmente de acuerdo
6	Usarlo no requiere esfuerzo.	Muy en desacuerdo								Totalmente de acuerdo
7	Puedo usarlo sin instrucciones escritas.	Muy en desacuerdo								Totalmente de acuerdo
8	No noto ninguna inconsistencia mientras lo uso.	Muy en desacuerdo								Totalmente de acuerdo
9	A los usuarios habituales y ocasionales les gustaría.	Muy en desacuerdo								Totalmente de acuerdo
10	Puedo recuperarme de los errores rápida y fácilmente.	Muy en desacuerdo								Totalmente de acuerdo
11	Puedo usarlo con éxito cada vez.	Muy en desacuerdo								Totalmente de acuerdo

			1	2	3	4	5	6	7	
1	Aprendí a usarlo rápidamente.	Muy en desacuerdo								Totalmente de acuerdo
2	Recuerdo fácilmente cómo usarlo.	Muy en desacuerdo								Totalmente de acuerdo
3	Es fácil aprender a usarlo.	Muy en desacuerdo								Totalmente de acuerdo
4	Rápidamente me volví hábil con el	Muy en desacuerdo								Totalmente de acuerdo

Figure 6: Questionnaire for instructors and administrators

For the administrative and instructor part, software is generated that allows the visualization of student preferences and takes the statistics of the courses historically to obtain those courses that have been selected the most, their schedules and periods. The software will implement data storytelling to identify key objectives and help more easily focus information. This will be done through several sections such as data summary or dashboards, which will show the information corresponding to the surveys. initials made to the students, the statistics of the students enrolled in the courses; allowing the filtering of information by shift, schedule, period and making top lists of the most selected and requested courses. Figure 7 shows the application home page showing the key course metrics, number of requests, and some recommendation notifications.

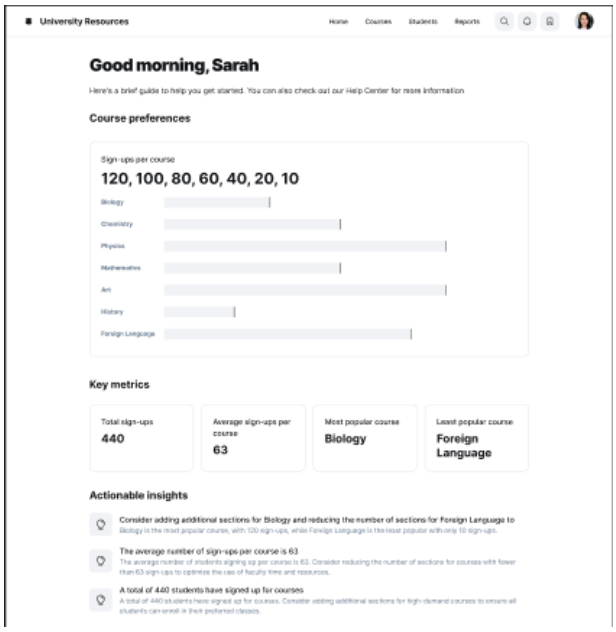


Figure 7: User Interface, Home page

In the overview section you can view the information corresponding to the results of each course, allowing you to filter by attendance, student grade, course grade, among others. Showing basic statistics (mean, median, mode) and presented in graphs of various types (Fig. 8).

The dashboard section shows the relevant information that the user requires to view, there will be the option to configure panels through filters and select the required information. The objective is for the user to be able to graphically visualize the data and focus on the objectives and key data in a simple way, which is why the use of personalized graphs for visualization is proposed. You can see 2 graphs on the dashboard, one corresponding to the top 10 of the most popular courses between 2021 and 2022 in a column graph (Fig. 8) and the second represented in a bar graph the top 10 of instructors in the same period of time (Fig. 9).

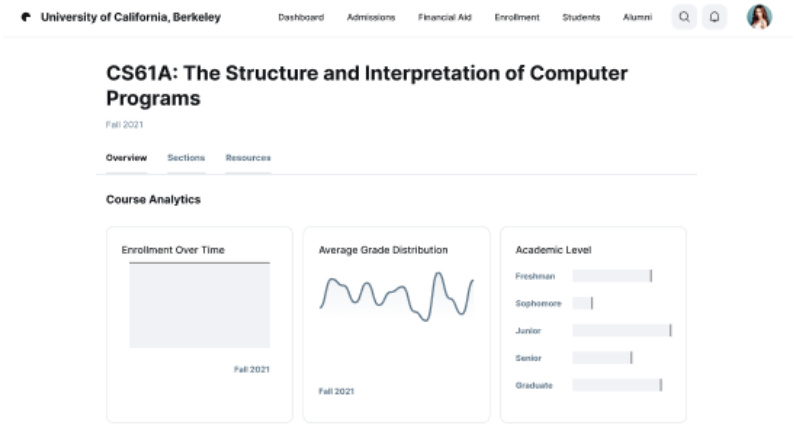


Figure 8: User interface overview

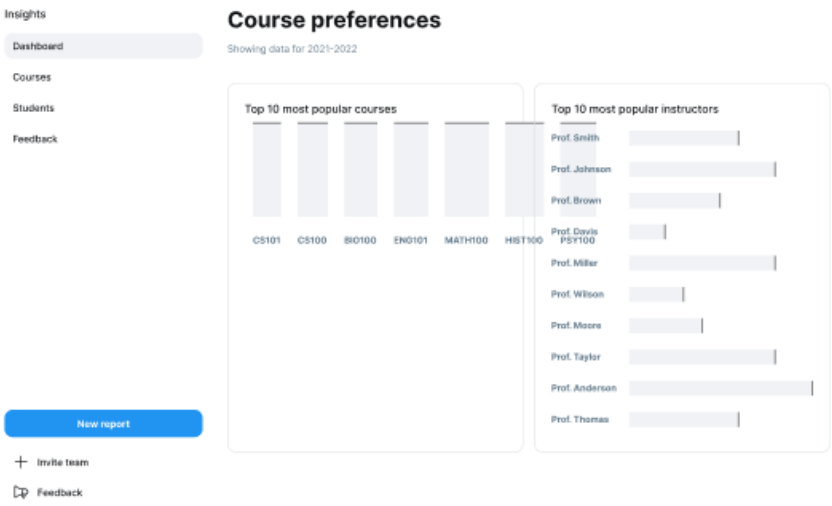


Figure 9: User interface Dashboard

5.3 Limitations of the study:

The limitations that we have for now in this case study are the number of students, a larger sample is required and the questionnaires must be expanded to include all university majors; Likewise, having a larger sample in terms of administrators and instructors for the use of the dashboard, for now the evaluation has only been carried out with the 680 students who were initially surveyed about the preference they have towards humanistic courses and 20 people who They serve as instructors or administrators, but the aim is to increase the number of administrators, instructors, students and careers to be able to make a more complete evaluation.

Also, as future work, it is intended that the dashboards be located on the university servers so that administrators, instructors and students can verify the availability of courses, propose more options, identify new preferences and easily and efficiently manage registrations and procedures. of all courses in each of the available periods.

6 Conclusions

After an exhaustive analysis of the different results obtained through the weka program to the knowledge base, it was determined that currently the most requested courses by the university community are the Gastronomy, Ballroom Dance and Zumba courses, but these courses They do not open a sufficient number of places to satisfy the large number of demand they have, so students have to look for other courses of less interest but that are also filled, such as Yoga, Graphology and Art with clay; However, even with these courses, student demand continues to be greater than the number of places needed, so finally students resort to courses that are not of interest to them but still have places to take them.

If in the future it is planned to open more courses, it should first be considered to open more groups of the most requested courses. If this is not possible due to lack of facilities or teachers, courses should be opened that have activities related to the most requested courses for way to meet student demand.

Regarding the use of data storytelling, users demonstrated a predilection for using dashboards with visual and striking identifiers, commenting that despite not receiving training on the interpretation of data or use of the dashboard, it was very easy for them to use and identify key points that They allowed them to manage and plan courses in a simpler way and according to the courses preferred by the students. As future work, it is intended to extend the interview to all students of the university to feed the course predilection dataset and continue using said dataset so that the dashboards can update the information each year and adjust the courses based on a history of previous years.

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