

Perception of students on blended learning considering data science and machine learning

Percepciones de los estudiantes sobre el blended learning considerando la ciencia de datos y el aprendizaje automático

Ricardo-Adán Salas-Rueda¹

¹ Universidad Nacional Autónoma de México, México

ricardo.salas@icat.unam.mx

ABSTRACT. This quantitative research aims to analyze the impact of audiovisual contents, discussion forums and online evaluations in the Blended learning modality through data science and machine learning. The sample is composed of 106 students from the careers of Administration, Commerce, Accounting, Marketing and Systems. The results of machine learning (linear regression) indicate that audiovisual contents, discussion forums and online evaluations in the Blended learning modality positively influence the teaching-learning process. On the other hand, data science identified 3 predictive models on the use of Blended learning by means of the decision tree technique. This research recommends the incorporation of the Blended learning modality during the planning and organization of school courses in order to develop the competencies of the students. Finally, Blended learning represents an alternative to improve teaching-learning conditions in the 21st century through the performance of synchronous and asynchronous school activities.

RESUMEN. Esta investigación cuantitativa tiene como objetivo analizar el impacto de los contenidos audiovisuales, la discusión en foros y las evaluaciones en línea bajo la modalidad Blended learning por medio de la ciencia de datos y el aprendizaje automático. La muestra está compuesta por 106 alumnos de las carreras de Administración, Comercio, Contaduría, Mercadotecnia y Sistemas. Los resultados del aprendizaje automático (regresión lineal) indica que los contenidos audiovisuales, la discusión en foros y las evaluaciones en línea bajo la modalidad Blended learning influyen positivamente en el proceso de enseñanza-aprendizaje. Por otro lado, la ciencia de datos identificó 3 modelos predictivos sobre el uso del Blended learning a través de la técnica árbol de decisión. Esta investigación recomienda la incorporación de la modalidad Blended learning durante la planeación y organización de los cursos escolares con la finalidad de desarrollar las competencias de los estudiantes. Finalmente, Blended learning representa una alternativa para mejorar las condiciones de enseñanza-aprendizaje en el Siglo XXI por medio de la realización de las actividades síncronas y asíncronas.

KEYWORDS: Blended learning, Higher education, Data science, Machine learning, Technology, ICT.

PALABRAS CLAVE: Blended learning, Educación superior, Ciencia de datos, Aprendizaje automático, Tecnología, TIC.

1. Introduction

Nowadays, educational institutions face the challenge of restructuring the content of the courses through technology in order to cover the needs and demands of the students (Ocampo, Gómez & Zambrano, 2015; Solorzano & Navio, 2019). Therefore, teachers seek, select and use various pedagogical and technological models to develop competencies (Daungcharone, Panjaburee & Thongkoo, 2019; Han, Wang & Jiang, 2019; Salas, Salas & Salas, 2019).

Universities are updating school activities and educational practices through technological tools to improve the assimilation of knowledge and development of skills in the students (Chiecher & Melgar, 2018). In particular, web applications and digital resources on the Internet allow the creation of innovative and useful spaces for the educational field (Cavanaugh, Hargis & Mayberry, 2016; Hernández & Juárez, 2018; Niekerk & Webb, 2016).

Digital tools, technological applications, web platforms, social networks and mobile devices are modifying the behaviors and actions of teachers and students inside and outside the classroom (Boelens, Voet & Wever, 2018; Salas, Salas, Salas & Vargas, 2019). In fact, educational institutions are promoting the use of Information and Communication Technologies (ICT) in school activities to improve the teaching-learning process (Al & Saeed, 2018; Thongkoo, Panjaburee & Daungcharone, 2019).

In particular, the Blended learning modality promotes the realization of school activities inside and outside the classroom through technology (Ellis & Bliuc, 2016; Han & Ellis, 2019; Harrison & West, 2014). For example, students perform online assessments, consult teaching resources on the Internet and interact in discussion forums (Pulham & Graham, 2018; Yamagata, 2014).

Blended learning is transforming the functions of teachers and students during the organization and realization of the educational process because this modality combines the characteristics of traditional learning and online learning through the Internet and ICT (Chang, Shu, Liang, Tseng & Hsu, 2014; Hilliard & Stewart, 2019; Lukenchuk, 2016).

The main advantages of Blended learning in the field of education are the flexibility of time and space during the teaching-learning process (Blaine, 2019; Harrison & West, 2014). Likewise, this learning modality increases motivation, improves academic performance and develops students' competences through the use of technology in school activities (Henrie, Bodily, Manwaring & Graham, 2015; Wang, Quek & Hu, 2017).

Therefore, this quantitative research aims to analyze the impact of audiovisual content, discussion forums and online evaluations in the Blended learning modality through data science and machine learning.

The research questions are:

- What is the impact of the Blended learning modality in the teaching-learning process through audiovisual contents, discussion forums and online evaluations?
- What are the predictive models on the use of Blended learning in the educational field?

2. Blended learning

Educational institutions are promoting the incorporation of Blended learning in school activities in order to improve the assimilation of knowledge and development of skills through technology (Boelens, Voet & Wever, 2018; Han, Wang & Jiang, 2019; Harrison & West, 2014). In particular, universities are increasing the use of Blended learning because this type of learning offers flexibility of time and space to students (Boelens, Voet & Wever, 2018).

The benefits of Blended learning are the creation of innovative school activities through ICT, reduction of

costs and development of competences in the students (Al & Saeed, 2018; Harrison & West, 2014). For example, the Blended learning modality improved the teaching-learning process on grammar in English through the performance of various asynchronous and synchronous activities on Blackboard and use of videos, presentations, audios, applications and open resources (Esparaza, Salinas & Glasserman, 2015).

The flipped classroom is a type of Blended learning where school activities are carried out inside and outside the classroom (Wang, Quek & Hu, 2017). Students consult different digital resources in their homes such as videos, readings and digital presentations and carry out activities in the face-to-face session such as discussion in forums, online assessments and collaborative work (Wang, Quek & Hu, 2017). For example, Salas (2018) proposes the use of the flipped classroom through the consultation of the audiovisual contents before the class and use of the Free DFD application during the face-to-face session to develop the competences of the students.

On the other hand, Blended synchronous learning offers space flexibility to students, allows immediate feedback and increases motivation during the educational process (Ocampo, Gómez & Zambrano, 2015; Wang, Quek & Hu, 2017). In this modality, students can attend the classroom and interact from anywhere through the technological and communication tools (Wang, Quek & Hu, 2017; Yamagata, 2014).

Several authors (e.g., Cavanaugh, Hargis & Mayberry, 2016; Wang, Quek & Hu, 2017; Yamagata, 2014) have used Blended learning to improve the assimilation of knowledge and facilitate the development of skills in the students.

Wang, Quek and Hu (2017) implemented Blended synchronous learning through videoconferences to improve teaching-learning conditions and offer space flexibility. On the other hand, Cavanaugh, Hargis and Mayberry (2016) propose the use of Learning Management System such as Sakai and Moodle to perform online evaluations and consultation of audiovisual content from any time and place.

Blackboard platform allowed the organization and realization of activities in the Blended learning in order to train teachers in the topics on Learning Projects (Ocampo, Gómez & Zambrano, 2015). Similarly, Yamagata (2014) used the Blackboard platform as a means of communication during the performance of various synchronous activities (virtual meetings) and asynchronous activities (discussion forums).

In the field of chemistry, the Blended learning modality improved academic performance and facilitated the assimilation of knowledge about microscopic phenomena through digital games (Hodges, Wang, Lee, Cohen & Jang, 2018). In addition, online resources such as videos and digital readings facilitate the educational process in the field of engineering (Niekerk & Webb, 2016).

Blended learning allows the collaboration among students and facilitates the search for information (Ellis, Pardo & Han, 2016). Similarly, Al and Saeed (2018) explain that the use of social networks and Learning Management System tools favor collaboration and promote discussion in the forums.

Educational institutions can improve the organization of school activities through Blended learning (Blaine, 2019; Prasad, Maag, Redestowicz & Hoe, 2018). In fact, this type of learning allows the planning of various tasks inside and outside the classroom through technology to improve academic performance and develop the skills of the students (Niekerk & Webb, 2016; Yamagata, 2014).

3. Method

This quantitative research aims to analyze the impact of audiovisual contents, discussion forums and online evaluations in the Blended learning modality through data science and machine learning.

The research hypotheses are:

- Hypothesis 1 (H1): Audiovisual contents in the Blended learning modality positively influence the teaching-learning process
- Hypothesis 2 (H2): Discussion forums in the Blended learning modality positively influence the teaching-learning process
- Hypothesis 3 (H3): Online evaluations in the Blended learning modality positively influence the teaching-learning process

Data science allows the construction of the following predictive models by means of the decision tree technique:

- Predictive model 1 on audiovisual contents in the Blended learning modality and teaching-learning process
- Predictive model 2 on discussion forums in the Blended learning modality and teaching-learning process
- Predictive model 3 on online evaluations in the Blended learning modality and teaching-learning process

3.1. Participants

The participants are 106 students who studied the careers of Administration, Commerce, Accounting, Marketing and Systems in a Mexican university during the 2017 school year (See Table 1). These students took various courses in the Blended learning modality during the first, second and third semesters. The average age is 18.98 years.

No.	Career	Man	Woman	Total	Average age
1	Administration	15	26	41	19.02 years
2	Commerce	15	15	30	18.80 years
3	Accounting	5	1	6	18.50 years
4	Systems	12	8	20	19.55 years
5	Marketing	3	6	9	18.44 years
		50	56	106	

Table 1. Participants. Source: Self-made.

3.2. Data analysis

This research uses the Rapidminer tool to analyze the impact of audiovisual contents, discussion forums and online evaluations in the Blended learning modality through machine learning (linear regression).

The Rapidminer tool allows the construction of 3 predictive models on Blended learning (audiovisual contents, discussion forums and online evaluations) by means of the decision tree technique. The information about the student profile, Blended learning modality and teaching-learning process is used during the construction of these predictive models (data science). In addition, SPSS software allows calculating Pearson correlation and Cronbach's alpha.

3.3. Data collection

The data collection was done in a Mexican university during the 2017 school year. Table 2 shows the measure instrument (questionnaire).

No.	Variable	Dimension	Question	Answer	n	%
1	Student profile	Sex	1. Indicate your sex.	Man	50	47.17%
				woman	56	52.83%
		Career	2. Indicate your career.	Administration	41	38.68%
				Commerce	30	28.30%
				Accounting	6	5.66%
				Systems	20	18.87%
	Marketing			9	8.49%	
	Age	3. Indicate your age.	18 years	49	46.23%	
			19 years	31	29.25%	
			20 years	15	14.15%	
			21 years	1	0.94%	
			22 years	10	9.43%	
	2	Blended learning	Audiovisual contents	4. Audiovisual contents in the Blended learning modality allow the flexibility of time and space.	Too much	26
Much					72	67.925%
Little					8	7.547%
Very little					0	0.000%
Discussion forums			5. Discussion forums in the Blended learning modality allow the flexibility of time and space.	Too much	52	49.057%
				Much	50	47.170%
				Little	4	3.774%
				Very little	0	0.000%
Online evaluations		6. Online evaluations in the Blended learning modality allow the flexibility of time and space.	Too much	55	51.887%	
			Much	47	44.340%	
			Little	4	3.774%	
			Very little	0	0.000%	
Teaching-learning		7. Synchronous and asynchronous activities in the Blended learning modality facilitate the teaching-learning process	Too much	60	56.604%	
			Much	43	40.566%	
			Little	3	2.830%	
			Very little	0	0.000%	

Table 2. Questionnaire. Source: Self-made.

Pock (2007) explains that the value of Cronbach's Alpha must be higher than 0.60 to cover the reliability requirement. The variable of Blended learning (Audiovisual contents, Discussion forums, Online evaluations and Teaching-learning) presents 0.687 for Cronbach's Alpha. Therefore, the measure instrument (questionnaire) covers the reliability requirement.

4. Results

Below are the results on the impact of audiovisual contents, discussion forums and online evaluations in the Blended learning modality.

4.1. Impact of Blended learning

Table 2 shows that Audiovisual contents ($n=72$, 67.925%), Discussion forums ($n=50$, 47.170%) and Online evaluations ($n=47$, 44.340%) in the Blended learning modality allow much the flexibility of time and space. Also, synchronous and asynchronous activities in the Blended learning modality facilitate too much ($n=60$, 56.604%), much ($n=43$, 40.566%) and little ($n=3$, 2.830%) the teaching-learning process.

The results of machine learning (linear regression) with 50%, 60% and 70% of training indicate that audiovisual contents, discussion forums and online evaluations in the Blended learning modality positively influence the teaching-learning process (See Table 3).

Hypothesis	Training	Linear regression	Conclusion	Error squared
H1: Audiovisual contents → teaching-learning process	50%	$y = 0.321x + 0.852$	Accepted: 0.321	0.365
	60%	$y = 0.302x + 0.922$	Accepted: 0.302	0.386
	70%	$y = 0.200x + 1.107$	Accepted: 0.200	0.383
H2: Discussion forums → teaching-learning process	50%	$y = 0.387x + 0.852$	Accepted: 0.387	0.184
	60%	$y = 0.458x + 0.760$	Accepted: 0.458	0.183
	70%	$y = 0.453x + 0.762$	Accepted: 0.453	0.178
H3: Online evaluations → teaching-learning process	50%	$y = 0.649x + 0.422$	Accepted: 0.649	0.235
	60%	$y = 0.636x + 0.490$	Accepted: 0.636	0.241
	70%	$y = 0.575x + 0.563$	Accepted: 0.575	0.218

Table 3. Results of machine learning. Source: Self-made.

4.2. Audiovisual contents

Audiovisual contents in the Blended learning modality allow too much ($n=26$, 24.528%), much ($n=72$, 67.925%) and little ($n=8$, 7.547%) the flexibility of time and space (See Table 2).

The results of machine learning (linear regression) with 50% (0.321), 60% (0.302) and 70% (0.200) of training indicate that hypothesis 1 is accepted (See Table 3). Consequently, audiovisual contents in the Blended learning modality positively influence the teaching-learning process.

Figure 1 shows the predictive model 1 on the use of Blended learning (accuracy of 67.92%). For example, if the student considers that audiovisual contents in the Blended learning modality allow too much the flexibility of time and space, has an age ≤ 19.5 years and attends the career of Administration then synchronous and asynchronous activities in the Blended learning modality facilitate too much the teaching-learning process.

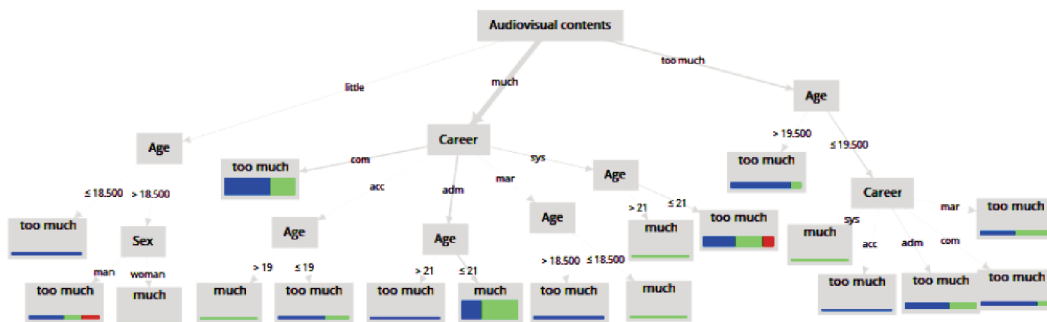


Figure 1. Predictive model 1 on the use of Blended learning. Source: Self-made.

Table 4 shows that the predictive model 1 identifies 18 conditions where synchronous and asynchronous activities in the Blended learning modality facilitate the teaching-learning process. For example, if the student considers that audiovisual contents in the Blended learning modality allow too much the flexibility of time and space, has an age ≤ 19.5 years and attends the career of Commerce then synchronous and asynchronous activities in the Blended learning modality facilitate too much the teaching-learning process.

No.	Audiovisual contents → flexibility of time and space	Career	Sex	Age	Synchronous and asynchronous activities → teaching-learning
1	Too much	-	-	> 19.5 years	Too much
2	Too much	Administration	-	≤ 19.5 years	Too much
3	Too much	Commerce	-	≤ 19.5 years	Too much
4	Too much	Accounting	-	≤ 19.5 years	Too much
5	Too much	Systems	-	≤ 19.5 years	Much
6	Too much	Marketing	-	≤ 19.5 years	Too much
7	Much	Commerce	-	-	Too much
8	Much	Administration	-	> 21 years	Too much
9	Much	Administration	-	≤ 21 years	Much
10	Much	Accounting	-	> 19 years	Much
11	Much	Accounting	-	≤ 19 years	Too much
12	Much	Systems	-	> 21 years	Much
13	Much	Systems	-	≤ 21 years	Too much
14	Much	Marketing	-	> 18.5 years	Too much
15	Much	Marketing	-	≤ 18.5 years	Much
16	Little	-	Man	> 18.5 years	Too much
17	Little	-	Woman	> 18.5 years	Much
18	Little	-	-	≤ 18.5 years	Too much

Table 4. Conditions in the predictive model 1. Source: Self-made.

4.3. Discussion forums

Discussion forums in the Blended learning modality allow too much ($n=52$, 49.057%), much ($n=50$, 47.170%) and little ($n=4$, 3.774%) the flexibility of time and space (See Table 2).

The results of machine learning with 50% (0.387), 60% (0.458) and 70% (0.453) of training indicate that hypothesis 2 is accepted (See Table 3). Therefore, discussion forums in the Blended learning modality positively influence the teaching-learning process.

Figure 2 shows the predictive model 2 on the use of Blended learning (accuracy of 81.13%). For example, if the student considers that discussion forums in the Blended learning modality allow too much the flexibility of time and space, has an age > 21.5 years and attends the career of Administration then synchronous and asynchronous activities in the Blended learning modality facilitate too much the teaching-learning process.

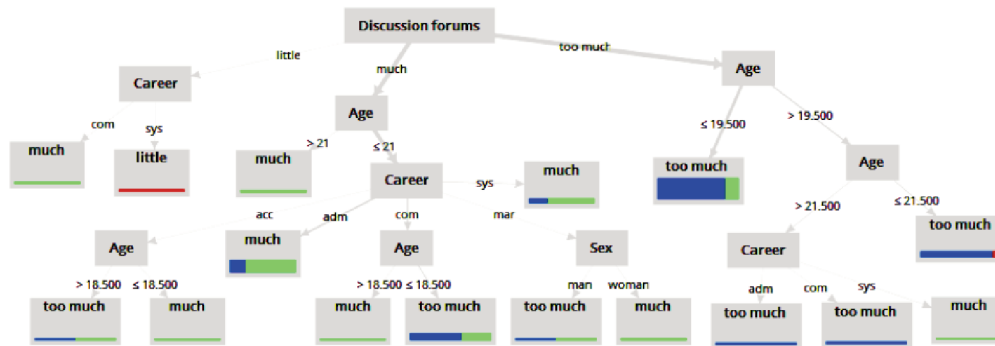


Figure 2. Predictive model 2 on the use of Blended learning. Source: Self-made.

Table 5 shows that the predictive model 2 identifies 14 conditions where synchronous and asynchronous activities in the Blended learning modality facilitate the teaching-learning process. For example, if the student considers that discussion forums in the Blended learning modality allow too much the flexibility of time and space, has an age > 21.5 years and attends the career of Commerce then synchronous and asynchronous activities in the Blended learning modality facilitate too much the teaching-learning process.

No.	Discussion forums → flexibility of time and space	Career	Sex	Age	Synchronous and asynchronous activities → teaching-learning
1	Too much	Administration	-	> 21.5 years	Too much
2	Too much	Commerce	-	> 21.5 years	Too much
3	Too much	Systems	-	> 21.5 years	Much
4	Too much	-	-	≤ 21.5 years	Too much
5	Too much	-	-	≤ 19.5 years	Too much
6	Much	-	-	> 21 years	Much
7	Much	Administration	-	≤ 21 years	Much
8	Much	Commerce	-	≤ 21 years and > 18.5 years	Much
9	Much	Commerce	-	≤ 18.5 years	Too much
10	Much	Accounting	-	≤ 21 years and > 18.5 years	Too much
11	Much	Accounting	-	≤ 18.5 years	Much
12	Much	Marketing	-	≤ 21 years	Much
13	Little	Commerce	-	-	Much
14	Little	Systems	-	-	Little

Table 5. Conditions in the predictive model 2. Source: Self-made.

4.4. Online evaluations

Online evaluations in the Blended learning modality allow too much (n=55, 51.887%), much (n=47, 44.340%) and little (n=4, 3.774%) the flexibility of time and space (See Table 2).

The results of machine learning with 50% (0.649), 60% (0.636) and 70% (0.575) of training indicate that hypothesis 3 is accepted (See Table 3). Therefore, online evaluations in the Blended learning modality positively influence the teaching-learning process. Figure 3 shows the predictive model 3 on the use of Blended learning (accuracy of 78.30%). For example, if the student considers that online evaluations in the Blended



learning modality allow too much the flexibility of time and space, has an age ≤ 20.5 years and attends the career of Marketing then synchronous and asynchronous activities in the Blended learning modality facilitate too much the teaching-learning process.

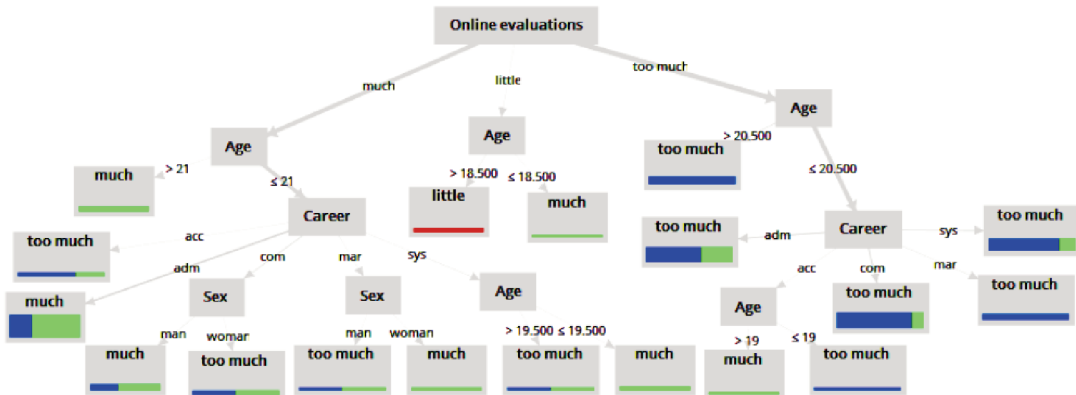


Figure 3. Predictive model 3 on the use of Blended learning. Source: Self-made.

Table 6 shows that the predictive model 3 identifies 17 conditions where synchronous and asynchronous activities in the Blended learning modality facilitate the teaching-learning process. For example, if the student considers that online evaluations in the Blended learning modality allow too much the flexibility of time and space, has an age ≤ 20.5 years and attends the career of Administration then synchronous and asynchronous activities in the Blended learning modality facilitate too much the teaching-learning process.

No.	Online evaluations → flexibility of time and space	Career	Sex	Age	Synchronous and asynchronous activities → teaching-learning
1	Too much	Marketing	-	≤ 20.5 years	Too much
2	Too much	Administration	-	≤ 20.5 years	Too much
3	Too much	Commerce	-	≤ 20.5 years	Too much
4	Too much	Accounting	-	≤ 20.5 years and > 19 years	Much
5	Too much	Accounting	-	≤ 19 years	Too much
6	Too much	Systems	-	≤ 20.5 years	Too much
7	Little	-	-	> 18.5 years	Little
8	Little	-	-	≤ 18.5 years	Much
9	Much	-	-	> 21 years	Much
10	Much	Administration	-	≤ 21 years	Much
11	Much	Commerce	Man	≤ 21 years	Much
12	Much	Commerce	Woman	≤ 21 years	Too much
13	Much	Systems	-	≤ 21 years and > 19.5 years	Too much
14	Much	Systems	-	≤ 19.5 years	Much
15	Much	Marketing	Woman	≤ 21 years	Much
16	Much	Marketing	Man	≤ 21 years	Too much
17	Much	Accounting	-	≤ 21 years	Too much

Table 6. Conditions in the predictive model 3. Source: Self-made.

Finally, Table 7 shows that the most significant relationships of the Pearson correlation are located in Teaching-learning/Online evaluations (0.616) and Online evaluations/Discussion forums (0.579).

	Audiovisual contents	Discussion forums	Online evaluations	Teaching-learning
Audiovisual contents	1	-	-	-
Discussion forums	0.057	1	-	-
Online evaluations	0.133	0.579	1	-
Teaching-learning	0.137	0.576	0.616	1

Table 7. Pearson correlation. Source: Self-made.



5. Discussion

Several authors (e.g., Esparaza, Salinas & Glasserman, 2015; Vaughan & Cloutier, 2017; Wang & Huang, 2018) state that the Blended learning modality allows improving the educational process through digital tools, web platforms and applications. In particular, the use of audiovisual contents in Blended learning improves the teaching-learning conditions (Lukenchuk, 2016; Salas, 2018; Wang, Quek & Hu, 2017).

5.1. Audiovisual contents

The results of machine learning (linear regression) with 50% (0.321), 60% (0.302) and 70% (0.200) of training indicate that audiovisual contents in the Blended learning modality positively influence the teaching-learning process. Also, audiovisual contents in the Blended learning modality allow too much (n=26, 24.528%), much (n=72, 67.925%) and little (n=8, 7.547%) the flexibility of time and space.

The decision tree technique (data science) identified 18 conditions in the predictive model 1 with an accuracy of 67.92%. For example, if the student considers that audiovisual contents in the Blended learning modality allow too much the flexibility of time and space, has an age ≤ 19.5 years and attends the career of Administration then synchronous and asynchronous activities in the Blended learning modality facilitate too much the teaching-learning process.

5.2. Discussion forums

Blended learning uses discussion forums to improve asynchronous and synchronous communication between teachers and students during the educational process (Lyons & Evans, 2013; Pulham & Graham, 2018).

The results of machine learning with 50% (0.387), 60% (0.458) and 70% (0.453) of training indicate that discussion forums in the Blended learning modality positively influence the teaching-learning process. Also, discussion forums in the Blended learning modality allow too much (n=52, 49.057%), much (n=50, 47.170%) and little (n=4, 3.774%) the flexibility of time and space.

Data science identified 14 conditions in predictive model 2 with an accuracy of 81.13%. For example, if the student considers that discussion forums in the Blended learning modality allow too much the flexibility of time and space, has an age > 21.5 years and attends the career of Administration then synchronous and asynchronous activities in the Blended learning modality facilitate too much the teaching-learning process.

5.3. Online evaluations

Likewise, online evaluations are used in the Blended learning modality to offer flexibility of time and space to students (Cavanaugh, Hargis & Mayberry, 2016; Pulham & Graham, 2018).

The results of machine learning with 50% (0.649), 60% (0.636) and 70% (0.575) of training indicate that online evaluations in the Blended learning modality positively influence the teaching-learning process. Also, online evaluations in the Blended learning modality allow too much (n=55, 51.887%), much (n=47, 44.340%) and little (n=4, 3.774%) the flexibility of time and space.

The decision tree technique identified 17 conditions in the predictive model 3 with an accuracy of 78.30%. For example, if the student considers that online evaluations in the Blended learning modality allow too much the flexibility of time and space, has an age ≤ 20.5 years and attends the career of Marketing then synchronous and asynchronous activities in the Blended learning modality facilitate too much the teaching-learning process.

Finally, asynchronous and synchronous activities in Blended learning facilitate the development of competences in students (Bower, Lee & Dalgarno, 2017; Diep, Zhu, Struyven & Blicck, 2017; Niekerk & Webb, 2016).

6. Conclusion

Blended learning represents an alternative to improve educational conditions through the organization and implementation of asynchronous and synchronous activities. In particular, audiovisual contents, discussion forums and online evaluations positively influence the teaching-learning process. In fact, the results of machine learning (linear regression) with 50%, 60% and 70% of training exceed the value of 0.190.

On the other hand, the decision tree technique (data science) identified 3 predictive models on the impact of Blended learning in the teaching-learning process with the accuracy greater than 67.90%.

This research recommends the incorporation of the Blended learning modality in school activities in order to build new virtual spaces for learning. In addition, the Rapidminer tool allows the calculation of machine learning and construction of predictive models (decision tree technique).

The limitations of this study are the analysis of audiovisual contents, discussion forums and online evaluations in the Blended learning modality during the educational process. Therefore, future research can assess the impact of digital games, social networks, educational platforms and web simulators on school activities.

The implications of this study are the importance of the Blended learning modality in the educational field. According to the participants, the audiovisual contents, discussion forums and online evaluations facilitate the flexibility of time and space during the teaching-learning process.

Finally, Blended learning is transforming the functions and behavior of teachers and students in the educational process through the creation of innovative and creative spaces for learning.

Cómo citar este artículo / How to cite this paper

Salas-Rueda, R. A. (2020). Perception of students on blended learning considering data science and machine learning. *Campus Virtuales*, 9(1), 125-135. (www.revistacampusvirtuales.es)

References

- Al Samarraie, H.; Saeed, N. (2018). A systematic review of cloud computing tools for collaborative learning: Opportunities and challenges to the blended-learning environment. *Computers & Education*, 124, 77-91. doi:10.1016/j.compedu.2018.05.016.
- Blaine, A. M. (2019). Interaction and presence in the virtual classroom: An analysis of the perceptions of students and teachers in online and blended Advanced Placement courses. *Computers & Education*, 132, 31-43. doi:10.1016/j.compedu.2019.01.004.
- Boelens, R.; Voet, M.; Wever, B. D. (2018). The design of blended learning in response to student diversity in higher education: Instructors' views and use of differentiated instruction in blended learning. *Computers & Education*, 120, 197-212. doi:10.1016/j.compedu.2018.02.009.
- Bower, M.; Lee, M. J.; Dalgarno, B. (2017). Collaborative learning across physical and virtual worlds: Factors supporting and constraining learners in a blended reality environment. *British Journal of Educational Technology*, 48(2), 407-430.
- Cavanaugh, C.; Hargis, J.; Mayberry, J. (2016). Participation in the Virtual Environment of Blended College Courses: An Activity Study of Student Performance. *The International Review of Research in Open and Distributed Learning*, 17(3), 263-275. doi:10.19173/irrodl.v17i3.1811.
- Chang, C. C.; Shu, K. M.; Liang, C.; Tseng, J. S.; Hsu, Y. S. (2014). Is blended e-learning as measured by an achievement test and self-assessment better than traditional classroom learning for vocational high school students?. *The International Review of Research in Open and Distributed Learning*, 15(2), 213-231. doi:10.19173/irrodl.v15i2.1708.
- Chiecher, A. C.; Melgar, M. F. (2018). Do they know everything? Educational innovations aimed at promoting digital skills in university students. *Apertura*, 10(2), 110-123.
- Daungcharone, K.; Panjaburee, P.; Thongkoo, K. (2019). A mobile game-based C programming language learning: results of university students' achievement and motivations. *International Journal of Mobile Learning and Organisation*, 13(2), 171-192.
- Diep, A.; Zhu, C.; Struyven, K.; Blicke, Y. (2017). Who or what contributes to student satisfaction in different blended learning modalities?. *British Journal of Educational Technology*, 48(2) 473-489.

- Ellis, R. A.; Bliuc, A. (2016). An exploration into first-year university students approaches to inquiry and online learning technologies in blended environments. *British Journal of Educational Technology*, 47(5), 970-980.
- Ellis, R. A.; Pardo, A.; Han, F. (2016). Quality in blended learning environments -Significant differences in how students approach learning collaborations. *Computers & Education*, 102, 90-102. doi:10.1016/j.compedu.2016.07.006.
- Esparaza Moguel, M. C.; Salinas Urbina, V.; Glasserman Morales, L. D. (2015). B-learning modality vs. face to face modality learning management in english grammar teaching. *Apertura*, 7(2), 1-10.
- Han, F.; Ellis, R. A. (2019). Identifying consistent patterns of quality learning discussions in blended learning. *The Internet and Higher Education*, 40(1), 12-19. doi:10.1016/j.iheduc.2018.09.002.
- Han, X.; Wang, Y.; Jiang, L. (2019). Towards a framework for an institution-wide quantitative assessment of teachers' online participation in blended learning implementation. *The Internet and Higher Education*, 42(1), 1-14. doi:10.1016/j.iheduc.2019.03.003.
- Harrison, J.; West, R. (2014). Sense of community in a blended technology integration course: A design-based research study. *The International Review of Research in Open and Distributed Learning*, 15(6), 290-312. doi:10.19173/irrodl.v15i6.1907.
- Henrie, C.; Bodily, R.; Manwaring, K.; Graham, C. (2015). Exploring intensive longitudinal measures of student engagement in blended learning. *The International Review of Research in Open and Distributed Learning*, 16(3), 131-155. doi:10.19173/irrodl.v16i3.2015.
- Hernández Gutiérrez, C.; Juárez Pacheco, M. (2018). Satisfaction of the students in a preparatory course of mathematics in e-modalities. *Apertura*, 10(2), 6-19. doi:10.32870/Ap.v10n2.1384.
- Hilliard, L. P.; Stewart, M. K. (2019). Time well spent: Creating a community of inquiry in blended first-year writing courses. *The Internet and Higher Education*, 41(1), 11-24. doi:10.1016/j.iheduc.2018.11.002.
- Hodges G. W.; Wang, L.; Lee, J.; Cohen, A.; Jang, Y. (2018). An exploratory study of blending the virtual world and the laboratory experience in secondary chemistry classrooms. *Computers & Education*, 122, 179-193. doi:10.1016/j.compedu.2018.03.003.
- Lukenchuk, A. (2016). Themes at the intersections of theory and practice in online and blended education. *Distance Education*, 37(1), 130-136. doi:10.1080/01587919.2016.1158771.
- Lyons T.; Evans, M. M. (2013). Blended Learning to Increase Student Satisfaction: An Exploratory Study. *Internet Reference Services Quarterly*, 18(1), 43-53. doi:10.1080/10875301.2013.800626.
- Niekerk, J. V.; Webb, P. (2016). The effectiveness of brain-compatible blended learning material in the teaching of programming logic. *Computers & Education*, 103, 16-27. doi:10.1016/j.compedu.2016.09.008.
- Ocampo López, A.; Gómez Zermeño, M. G.; Zambrano Izquierdo, D. (2015). Teachers' perception of blended learning courses to develop work Competencies. *Apertura*, 7(2), 1-12.
- Pock, A. (2007). *Strategic Management in Islamic Finance*. Germany: Springer.
- Prasad, P. W.; Maag, A.; Redestowicz, M.; Hoe, L. S. (2018). Unfamiliar technology: Reaction of international students to blended learning. *Computers & Education*, 122, 92-103. doi:10.1016/j.compedu.2018.03.016.
- Pulham, E.; Graham, C. R. (2018). Comparing K-12 online and blended teaching competencies: a literature review. *Distance Education*, 39(3), 411-432. doi:10.1080/01587919.2018.1476840.
- Salas Rueda, R. A. (2018). Analysis on the Use of Continuous Improvement, Technology and Flipped Classroom in the Teaching-Learning Process by means of Data Science. *Online Journal of Communication and Media Technologies*, 8(4), 325-343. doi:10.12973/ojcm/3955.
- Salas Rueda, R. A.; Salas Rueda, E. P.; Salas Rueda, R. D. (2019). Design and use of a web application for the field of statistics considering the assure model and data science. *Texto Livre: Linguagem e Tecnologia*, 12(1), 1-24.
- Salas Rueda, R. A.; Salas Rueda, E. P.; Salas Rueda, R. D.; Vargas Pérez, Y. M. (2019). Analysis of the Web Application for the Punctual Estimation by means of data science. *Revista Dilemas Contemporáneos: Educación, Política y Valores*, 6(2), 1-25.
- Solorzano Garcia, M.; Navio Marco, J. (2019). Developing social entrepreneurs through distance education: the value of commitment and interactivity with the learning community. *International Journal of Mobile Learning and Organisation*, 13(1), 30-50.
- Thongkoo, K.; Panjaburee, P.; Daungcharone, K. (2019). A development of ubiquitous learning support system based on an enhanced inquiry-based learning approach. *International Journal of Mobile Learning and Organisation*, 13(2), 129-151.
- Vaughan, N.; Cloutier, D. (2017). Evaluating a blended degree program through the use of the NSSE framework. *British Journal of Educational Technology*, 48(5), 1176-1187.
- Wang, Q.; Huang, C. (2018). Pedagogical, social and technical designs of a blended synchronous learning environment. *British Journal of Educational Technology*, 49(3), 451-462.
- Wang, Q.; Quek, C.; Hu, X. (2017). Designing and Improving a Blended Synchronous Learning Environment: An Educational Design Research. *The International Review of Research in Open and Distributed Learning*, 18(3), 99-118. doi:10.19173/irrodl.v18i3.3034.
- Yamagata Lynch, L. (2014). Blending online asynchronous and synchronous learning. *The International Review of Research in Open and Distributed Learning*, 15(2), 189-212. doi:10.19173/irrodl.v15i2.1778.