Teachers' Opinion About Collaborative Virtual Walls and Massive Open Online Course During the COVID-19 Pandemic

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ARTICLE INFO	ABSTRACT
	During the COVID-19 pandemic, Mexican universities incorporated technological tools to update the activities of the courses under the distance modality. This quantitative research analyzes the teachers' perception about Collaborative Virtual Walls (CVWs) and Massive Open Online Courses (MOOCs) through data science. The participants are 54 professors from the National Autonomous University of Mexico who completed the International Diploma "Innovation in University Teaching 2021". The results of machine learning indicate that CVWs and MOOCs positively influence the learning and participation of the students. Likewise, the decision tree technique identifies 4 predictive models about these technological tools. This study recommends the incorporation of ICTs in the educational field because teachers can organize and carry out creative activities under the distance modality. Even universities can include in their strategic planning the incorporation of CVWs and MOOCs in the educational process. The limitations of this research are the sample and analysis about the perception of the teachers in a Mexican university. Therefore, future research can analyze CVWs and MOOCs considering the development of skills and satisfaction of the students in the middle schools, high schools and universities. In conclusion, teachers rely on technological advances such as CVWs and MOOCs to create new school activities under the distance modality and improve the teaching-learning conditions during the COVID-19 pandemic. **Keywords:** virtual walls, MOOCs, teachers, data science

INTRODUCTION

Today, the planning, organization and updating of the courses with the support of technology have great relevance due to the emergence of the COVID-19 pandemic (Beneria et al., 2020; Bergsman & Chudler, 2021; Chandrasinghe et al., 2020; Colomo-Magaña et al., 2021). In particular, teachers design new school activities under the distance modality in order to facilitate the learning process (Daniel, 2020; Guo & Zhang, 2017; Zuo et al., 2021). Likewise, universities use CVWs and MOOCs to carry out creative school activities from anywhere (De-Witt & Koh, 2020; Pottier et al., 2020; Zhu et al., 2020).

Information and Communication Technologies (ICTs) allow teachers to build new educational spaces where students actively participate, assimilate the knowledge and develop their skills (Birisci & Kul, 2019; Chen et al., 2021; García-Peñalvo et al., 2019; Howlett & Waemusa, 2018). In fact, technological tools are revolutionizing the realization and implementation of the school activities in the 21st century (Colton, 2020; Gambari et al., 2018; Ingulfsen et al., 2018; Zuo et al., 2021). In Mexico, the use of CVWs in the educational field improved the teaching-learning conditions in high schools and universities because the students had an active role before, during and after the face-to-face sessions (Salas-Rueda et al., 2021). In the same way, universities in the United States rely on MOOCs to facilitate the assimilation of knowledge and develop the students' skills from anywhere (Moore & Wang, 2021).

COVID-19 pandemic caused teachers to update their courses through technological tools such as web platforms, video conferencing systems, CVWs and MOOCs (Boer, 2021; Cahoon et al., 2021; Sangster et al., 2020). CVWs allow students to exchange and share the information of the courses inside and outside the classroom (Andrews et al., 2020; De-Witt & Koh, 2020; Eiland, 2018). For example, Padlet promotes the active role of the students at any time through the discussion forums (De-Witt & Koh, 2020; Zou & Xie, 2019). Likewise, teachers use MOOCs to innovate the learning process and facilitate the assimilation of knowledge (Pérez-Sanagustín et al., 2017; Zhu et al., 2020). Even these technological tools allow the interaction and communication between teachers and students from anywhere (Pottier et al., 2020; Taranto et al., 2020; Zhu et al., 2020).

During the COVID-19 pandemic, Mexican universities incorporated technological tools to update the activities of the courses under the distance modality. This quantitative research analyzes the teachers' perception about CVWs and MOOCs through data science. Therefore, the research questions are:

- What is the perception of the teachers about CVWs and MOOCs during the COVID-19 pandemic?
- What is the impact of CVWs and MOOCs in the learning and participation of the students considering machine learning?
- What are the predictive models about CVWs, MOOCs and the teacher's profile considering the decision tree technique?

LITERATURE REVIEW

During the COVID-19 pandemic, teachers changed their roles in the educational process (Beneria et al., 2020; Chandrasinghe et al., 2020; Colomo-Magaña et al., 2021; Daniel, 2020). Therefore, technological advances play a fundamental role in the planning, organization, and implementation of new school activities under the distance modality (Beriswill et al., 2016; Kilicer et al., 2018; Pechenkina et al., 2018; Stockleben et al., 2017; Zuo et al., 2021).

Impact of the COVID-19 Pandemic in the Educational Field

Educational institutions are updating the courses under the distance modality due to the emergence of the COVID-19 pandemic (Boer, 2021; Cahoon et al., 2021; Sangster et al., 2020). Consequently, teachers are incorporating technological tools and web platforms to create new educational virtual spaces (Atiles et al., 2021; Salas-Rueda, 2021; Zhong et al., 2021). For example, the students of tourism used web platforms to interact and communicate with the teacher from anywhere (Zhong et al., 2021).

In the accounting courses, use of flipped classroom and educational web platforms such as Moodle and Google Classroom facilitated the learning process during the COVID-19 pandemic (Sangster et al., 2020). Similarly, the ADDIE pedagogic model and the construction of the JDE application facilitated the assimilation of knowledge and development of skills in the field of electronics (Salas-Rueda, 2021).

Pedagogical models and technological advances improved the teaching-learning conditions about Accounting (Sangster et al., 2020), Electronics (Salas-Rueda, 2021), and Tourism (Zhong et al., 2021) during the COVID pandemic-19. Incorporation of technologies such as CVWs and MOOCs in the school activities allows educational systems to meet the needs of the students through the distance modality (Andrews et al., 2020; Taranto et al., 2020).

CVWs

Teachers used CVWs such as Padlet in order to improve the learning process in the courses of the English Language (Zou & Xie, 2019), Chemistry (Andrews et al., 2020), Social Science (Salas-Rueda et al., 2020), Finance (De-Witt & Koh, 2020), Medicine (Eiland, 2018), and Geometric Representation Systems (Salas-Rueda et al., 2021). In the English course, the teacher used flipped classroom to update the school activities before, during, and after the face-to-face sessions (Zou & Xie, 2019). In particular, these students used Padlet to exchange the ideas at any time, encourage the critical thinking, increase the motivation during the learning process and develop their writing skills (Zou & Xie, 2019).

The benefits of CVWs are the flexibility of time and space during the teaching-learning process, exchange of the ideas between the participants of the educational process and active role of the students (De-Witt & Koh, 2020; Zou & Xie, 2019). In the Finance course, the students improved their academic performance and increased their motivation during the face-to-face sessions through the exchange of the ideas in Padlet (De-Witt & Koh, 2020).

The incorporation of CVWs in the educational field allows that teachers organize and carry out creative activities inside and outside the classroom (De-Witt & Koh, 2020; Eiland, 2018; Zou & Xie, 2019). In Mexico, the use of CVWs facilitated the learning process about Geometric Representation Systems and improved the participation of the students in the classroom through the exchange of the ideas (Salas-Rueda et al., 2021). Similarly, the students at high school used the pedagogical model called "Classroom of the Future", CVWs and mobile devices to discuss the social science topics (Salas-Rueda et al., 2020).

In the Drugs in Pregnancy course, the students used Padlet to actively participate through the discussion forums (Eiland, 2018). Likewise, the teacher of the Chemistry course promoted the collaborative work through the use of this virtual wall (Andrews et al., 2020). Finally, teachers have the opportunity to carry out creative school activities and encourage the participation of the students through CVWs (Andrews et al., 2020; Eiland, 2018).

MOOCs

Various authors (e.g., Pérez-Sanagustín et al., 2017; Taranto et al., 2020; Zhu et al., 2020) consider that the use of MOOCs in the educational field allows innovating the school activities and facilitate the teaching-learning process. In fact, this technological tool has been used in the universities of Italy (Taranto et al., 2020), Switzerland (De-Castaneda et al., 2015), France (Pottier et al., 2020) and United States (Moore & Wang, 2021). In the Medicine course, the students improved their academic performance and assimilated the knowledge about health issues at any time through MOOCs (Annaraud & Singh, 2017).

At the University of Turin, the MOOC called "Math MOOC UniTO" facilitated the communication between the participants of the educational process, assimilation of knowledge about mathematics and development of the skills (Taranto et al., 2020). Similarly, the students of the Medicine course used a MOOC to assimilate the knowledge about the Ebola disease and improve their academic performance (De-Castaneda et al., 2015).

The benefits of MOOCs in the educational field are the development of skills, learning from anywhere, assimilation of knowledge at any time and active role of the students (Pottier et al., 2020; Zhu et al., 2020). In the English as a Foreign Language course, the students developed their communication and grammar skills through MOOCs (Martín-Monje et al., 2018). Also, the students of the Physical course increased their motivation and academic performance through the use of the MOOC called "Super Earths and Life" (Moore & Wang, 2021).

In France, the students of the Medicine course understood the obesity treatment topics and developed their skills through a MOOC (Pottier et al., 2020). In conclusion, the incorporation of MOOCs in the educational field improved the teaching-learning conditions about Mathematics (Taranto et al., 2020), Medicine (De-Castaneda et al., 2015; Pottier et al., 2020), Health (Annaraud & Singh, 2017), and Physics (Moore & Wang, 2021).
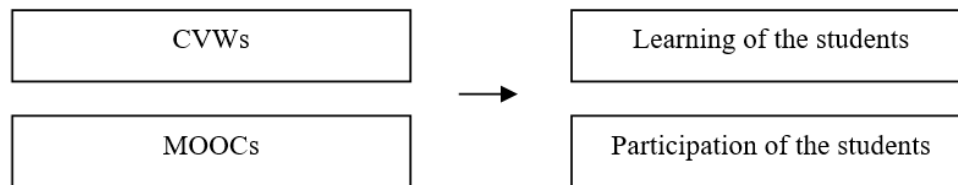
Figure 1. Model used in this quantitative research

METHOD

The particular aims of this quantitative research are (1) analyze the teachers' perception about CVWs and MOOCs during the COVID-19 pandemic (2) analyze the impact about CVWs and MOOCs in the learning and participation of the students through machine learning (linear regression) and (3) identify the predictive models about CVWs, MOOCs and the teacher's profile through the decision tree technique.

Participants

The participants are 54 professors (16 men and 38 women) from the National Autonomous University of Mexico who completed the International Diploma "Innovation in University Teaching 2021". These teachers have the academic degree of Bachelor (n = 15, 27.78%), Master (n = 27, 50.00%) and Doctorate (n = 12, 22.22%). Non-probability sampling was used in this study.

Procedure

During the COVID-19 pandemic, teachers used ICTs in order to carry out the learning process under the distance modality and build new educational spaces. **Figure 1** shows the model used to analyze the teachers' perception about CVWs and MOOCs.

Various authors (e.g., Andrews et al., 2020; Eiland, 2018; Zou & Xie, 2019) mention that CVWs allow the construction of new spaces where students learn and participate during the teaching-learning process. Therefore, the hypotheses about CVWs are:

- Hypothesis 1 (H1): CVWs positively influence the learning of the students
- Hypothesis 2 (H2): CVWs positively influence the participation of the students

Likewise, MOOCs improve the teaching-learning conditions and facilitate the active role of students (Pérez-Sanagustín et al., 2017; Pottier et al., 2020; Taranto et al., 2020). Therefore, the hypotheses about MOOCs are:

- Hypothesis 3 (H3): MOOCs positively influence the learning of the students
- Hypothesis 4 (H4): MOOCs positively influence the participation of the students

The decision tree technique used the information about the teacher's profile, CVWs and MOOCs to build the following predictive models:

- Predictive Model 1 (PM1) about CVWs and the learning of the students
- Predictive Model 2 (PM2) about CVWs and the participation of the students
- Predictive Model 3 (PM3) about MOOCs and the learning of the students
- Predictive Model 4 (PM4) about MOOCs and the participation of the students

Data Collection

Table 1 shows the questionnaire used to collect the information during the "Innovation in University Teaching 2021" Diploma.

Table 2 shows the validation of the questionnaire by means of the Load factor, Cronbach's Alpha, Average Variance Extracted and Composite Reliability.

Table 1. Questionnaire about CVWs and MOOCs

No.	Variable	Dimension	Question	Answer	n	%
1	Profile of teacher	Sex	1. What is your sex?	Man	16	29.63%
				Woman	38	70.37%
		Maximum degree of study	2. What is your maximum degree of study?	Bachelor	15	27.78%
				Master	27	50.00%
				Doctorate	12	22.22%
		Age	3. What is your age?	Open	-	-
2	Technology in the educational field	CVWs	4. CVWs facilitate the creation of new school activities	Very much (1)	26	48.15%
				Much (2)	10	18.52%
				Little (3)	12	22.22%
				Very little (4)	6	11.11%
		MOOCs	5. MOOCs facilitate the creation of new school activities	Very much (1)	24	44.44%
				Much (2)	11	20.37%
				Little (3)	13	24.07%
				Very little (4)	6	11.11%
		Learning of the students	6. The use of technology facilitates the learning of the students	Very much (1)	37	68.52%
				Much (2)	10	18.52%
				Little (3)	7	12.96%
				Very little (4)	0	0.00%
		Participation of the students	7. The use of technology facilitates the participation of the students	Very much (1)	36	66.67%
				Much (2)	13	24.07%
				Little (3)	5	9.26%
				Very little (4)	0	0.00%

Table 2. Validation of the questionnaire

Variable	Dimension	Load factor	Cronbach's Alpha	Average Variance Extracted	Composite Reliability
Technology in the educational field	CVWs	0.652			
	MOOCs	0.718			
	Learning	0.726	0.659	0.513	0.807
	Participation	0.765			

Data Analysis

This research used the free RapidMiner tool to analyze the teachers' perception about CVWs and MOOCs through data science (machine learning and decision tree techniques). This application can be downloaded at https://rapidminer.com/

The RapidMiner tool allowed calculating machine learning (linear regressions) to evaluate the hypotheses about CVWs and MOOCs. The training section with 50% (n = 27), 60% (n = 32), and 70% (n = 38) of the sample allowed the calculation of the linear regressions and the evaluation section with 50% (n = 27), 40% (n = 22), and 30% (n = 16) of the sample allowed establishing the accuracy of these regressions by means of the squared error.

On the other hand, the information about the teacher's profile (sex, age and maximum degree of study), CVWs and MOOCs allow the construction of the predictive models through the decision tree technique.

RESULTS

The use of technology facilitates *very much* (n = 37, 68.52%), *much* (n = 10, 18.52%), and *little* (n = 7, 12.96%) the learning of the students (See **Table 1**). Likewise, the use of technology facilitates *very much* (n = 36, 66.67%), *much* (n = 13, 24.07%), and *little* (n = 5, 9.26%) the participation of the students. Also, the results of machine learning indicate that CVWs and MOOCs positively influence the learning and participation of the students (See **Table 3**).

Table 3. Results of machine learning

Hypothesis	Training	Linear regression	Conclusion	t-value	p-value	Squared error
H1: CVWs → learning of the students	50%	y = 0.289x + 0.897	Accepted: 0.289	2.341	0.027	0.649
	60%	y = 0.316x + 0.814	Accepted: 0.316	3.062	0.004	0.817
	70%	y = 0.283x + 0.910	Accepted: 0.283	2.926	0.005	0.863
H2: CVWs → participation of the students	50%	y = 0.305x + 0.751	Accepted: 0.305	2.833	0.009	0.544
	60%	y = 0.313x + 0.726	Accepted: 0.313	3.494	0.001	0.677
	70%	y = 0.297x + 0.778	Accepted: 0.297	3.863	0.000	0.848
H3: MOOCs → learning of the students	50%	y = 0.192x + 1.091	Accepted: 0.192	1.560	0.131	0.490
	60%	y = 0.204x + 1.003	Accepted: 0.204	1.893	0.068	0.564
	70%	y = 0.260x + 0.905	Accepted: 0.260	2.759	0.009	0.660
H4: MOOCs → participation of the students	50%	y = 0.115x + 1.149	Accepted: 0.115	1.009	0.322	0.419
	60%	y = 0.130x + 1.066	Accepted: 0.130	1.304	0.201	0.504
	70%	y = 0.178x + 0.971	Accepted: 0.178	2.143	0.038	0.648

Table 4. Pearson correlations

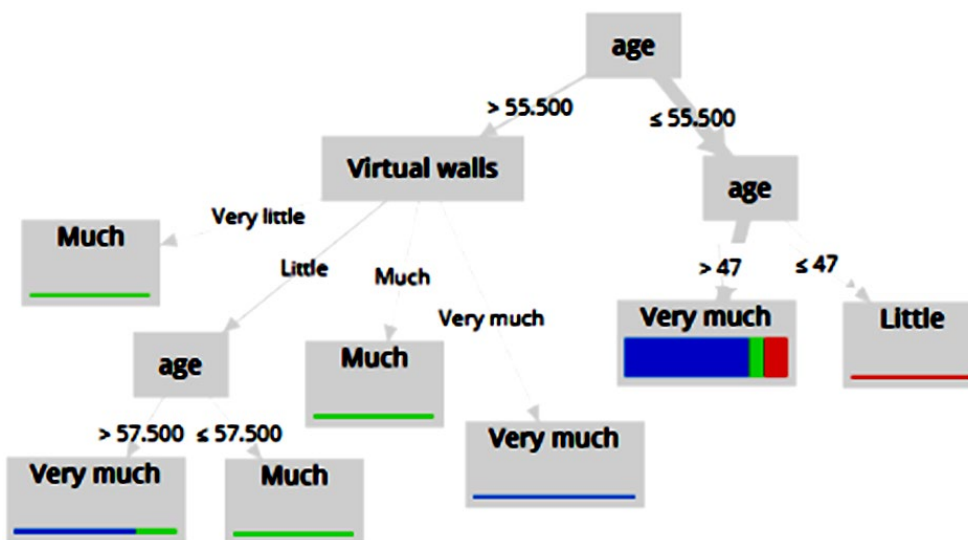|	CVWs	MOOCs	Learning	Participation
CVWs	1	-	-	-
MOOCs	0.456	1	-	-
Learning	0.192	0.308	1	-
Participation	0.286	0.308	0.547	1

Figure 2. PM1 about CVWs

Table 4 shows the Pearson's correlations about CVWs, MOOCs, learning and participation of the students.

CVWs

CVWs facilitate *very much* (n = 26, 48.15%), *much* (n = 10, 18.52%), *little* (n = 12, 22.22%), and *very little* (n = 6, 11.11%) the creation of new school activities (See **Table 1**). The results of machine learning with 50% (0.289, t_value = 2.341, p_value = 0.027), 60% (0.316, t_value = 3.062, p_value = 0.004) and 70% (0.283, t_value = 2.926, p_value = 0.005) of training indicate that H1 is accepted (See **Table 3**). Therefore, CVWs positively influence the learning of the students.

Figure 2 shows 7 conditions of the PM1 with the accuracy of 79.63%. For example, if the teacher considers that CVWs facilitate *very much* the creation of new school activities and has an age > 55.5 years then the use of technology facil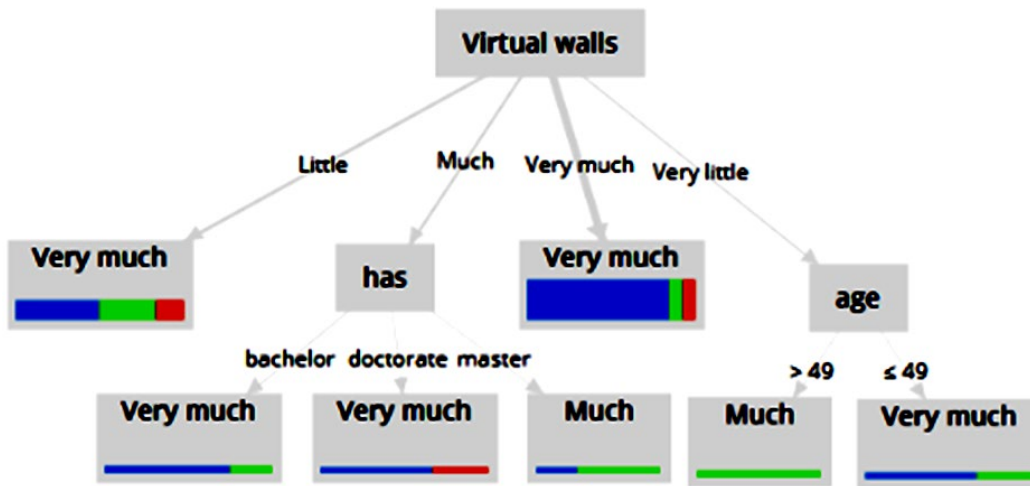itates *very much* the learning of the students. On the other hand, if the teacher considers that CVWs facilitate *much* the creation of new school activities and has an age > 55.5 years then the use of technology facilitates *much* the learning of the students.
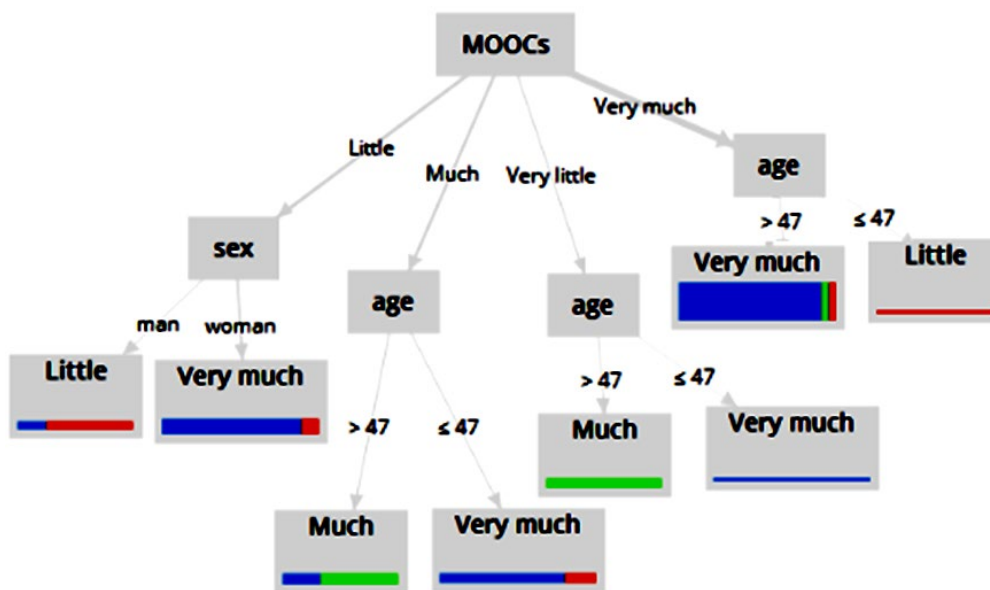
Figure 3. PM2 about CVWs

Figure 4. PM3 about MOOCs

The results of machine learning with 50% (0.305, t_value = 2.833, p_value = 0.009), 60% (0.313, t_value = 3.494, p_value = 0.001) and 70% (0.297, t_value = 3.863, p_value = 0.000) of training indicate that H2 is accepted (See **Table 3**). Therefore, CVWs positively influence the participation of the students.

Figure 3 shows 7 conditions of the PM2 with the accuracy of 74.07%. For example, if the teacher considers that CVWs facilitate *much* the creation of new school activities and has the doctorate then the use of technology facilitates *very much* the participation of the students. On the other hand, if the teacher considers that CVWs facilitate *much* the creation of new school activities and has the master then the use of technology facilitates *much* the participation of the students.

MOOCs

MOOCs facilitate *very much* (n = 24, 44.44%), *much* (n = 11, 20.37%), *little* (n = 13, 24.07%), and *very little* (n = 6, 11.11%) the creation of new school activities (See **Table 1**). The results of machine learning with 50% (0.192, t_value = 1.560, p_value = 0.131), 60% (0.204, t_value = 1.893, p_value = 0.068) and 70% (0.260, t_value = 2.759, p_value = 0.009) of training indicate that H3 is accepted (See **Table 3**). Therefore, MOOCs positively influence the learning of the students.

Figure 4 shows 8 conditions of the PM3 with the accuracy of 87.04%. For example, if the teacher considers that MOOCs facilitate *very much* the creation of new school activities and has an age > 47 years then the use
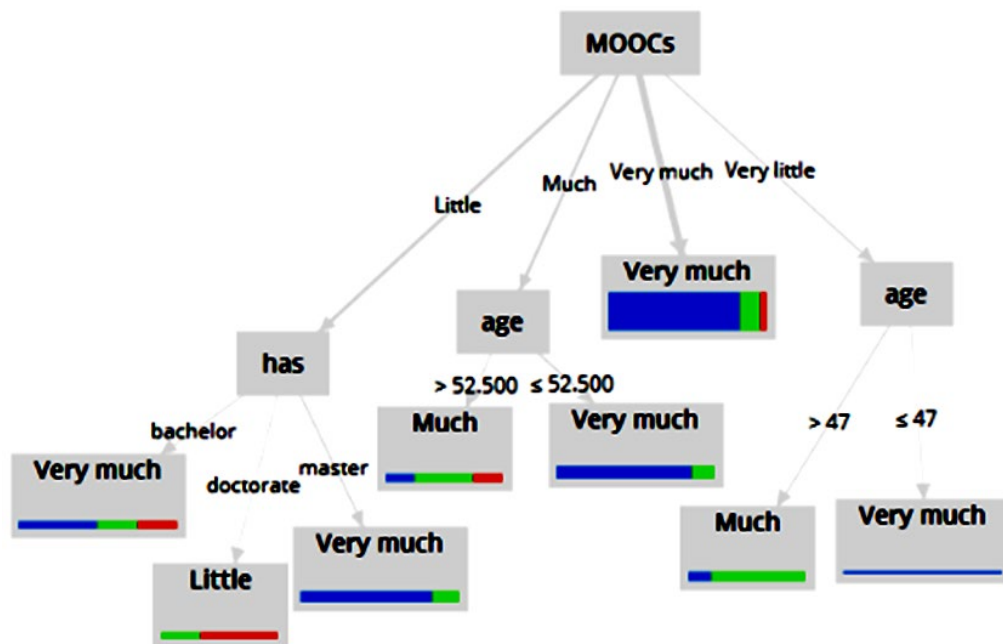
Figure 5. PM4 about MOOCs

of technology facilitates *very much* the learning of the students. On the other hand, if the teacher considers that MOOCs facilitate *much* the creation of new school activities and has an age > 47 years then the use of technology facilitates *much* the learning of the students.

The results of machine learning with 50% (0.115, t_value = 1.009, p_value = 0.322), 60% (0.130, t_value = 1.304, p_value = 0.201), and 70% (0.178, t_value = 2.143, p_value = 0.038) of training indicate that H4 is accepted (See **Table 3**). Therefore, MOOCs positively influence the learning of the students.

Figure 5 shows 8 conditions of the PM4 with an accuracy of 77.78%. For example, if the teacher considers that MOOCs facilitate *much* the creation of new school activities and has an age > 52.5 years then the use of technology facilitates *much* the participation of the students. On the other hand, if the teacher considers that MOOCs facilitate *very much* the creation of new school activities then the use of technology facilitates *very much* the participation of the students.

DISCUSSION

Various authors (e.g., Chen et al., 2021; Hava & Gelibolu, 2018; Ingulfsen et al., 2018; Parra et al., 2019) mention that teachers use ICTs to carry out creative activities and build new virtual spaces for learning. As a result of the analysis performed, 68.52% of the teachers (n = 37) consider that the use of technology facilitates *very much* the learning of the students. Likewise, the use of technology facilitates *much* (n = 10, 18.52%) the learning of the students. Consequently, majority of the teachers (87.04%) have a favorable opinion about this aspect. Likewise, this study shares the ideas of various authors (e.g., Boer, 2021; Cahoon et al., 2021) about the incorporation of technological tools in the school activities to meet the needs of the students during the COVID-19 pandemic.

Educational institutions promote the active role of the students during the teaching-learning process through the use of ICTs (García-Peñalvo et al., 2019; Moore & Wang, 2021; Stockleben et al., 2017). In particular, 66.67% of the teachers (n = 36) consider that the use of technology facilitates *very much* the participation of the students. Analysis showed that the use of technology facilitates *much* (n = 13, 24.07%) the participation of the students. Consequently, the majority of teachers (90.74%) have a favorable opinion about this aspect. This research confirms the findings of various authors (e.g., Cahoon et al., 2021; Boer, 2021) about the use of ICTs to promote the active role of students.

CVWs

Today, teachers use virtual walls to facilitate the learning process, develop the skills and encourage the participation of the students (Andrews et al., 2020; De-Witt & Koh, 2020; Eiland, 2018; Zou & Xie, 2019). As a result of the analysis performed, 48.15% of the teachers (n = 26) consider that CVWs facilitate *very much* the creation of new school activities. Also, CVWs facilitate *much* (n = 10, 18.52%) the creation of new school activities. Therefore, the majority of the teachers (66.67%) have a favorable opinion about this technological tool.

Similar to Zou and Xie (2019), the use of the virtual wall improved the teaching-learning conditions through the exchange of the ideas. The results of machine learning about H1 are higher than 0.280, therefore, CVWs positively influence the learning of the students. Consequently, the teachers at the National Autonomous University of Mexico consider that this technological tool improves the teaching-learning conditions during the COVID-19 pandemic.

Data science identified 7 conditions of the PM1 where the age of the teacher determines how virtual walls influence the learning. In fact, the decision tree technique presents 3 conditions where the use of technology facilitates *very much* the learning of the students. For example, if the teacher considers that CVWs facilitate *very much* the creation of new school activities and has an age > 55.5 years then the use of technology facilitates *very much* the learning of the students.

Also, data science presents 3 conditions where the use of technology facilitates *much* the learning of the students. For example, if the teacher considers that CVWs facilitate *much* the creation of new school activities and has an age > 55.5 years then the use of technology facilitates *much* the learning of the students. Finally, this model presents 1 condition where the use of technology facilitates *little* the learning of the students.

This research shares the ideas of various authors (e.g., Andrews et al., 2020; De-Witt & Koh, 2020; Zou & Xie, 2019) about the use of virtual walls to facilitate the active role of the students inside and outside the classroom. The results of machine learning about H2 are higher than 0.290, therefore, CVWs positively influence the participation of the students. Consequently, this technological tool favors the teaching-learning conditions during the COVID-19 pandemic.

Data science identified 7 conditions of the PM2 where the age and educational level of the teacher determine how virtual walls influence the participation of the students. In fact, the decision tree technique presents 5 conditions where the use of technology facilitates *very much* the participation of the students. For example, if the teacher considers that CVWs facilitate *much* the creation of new school activities and has the doctorate then the use of technology facilitates *very much* the participation of the students.

Also, data science presents 2 conditions where the use of technology facilitates *much* the participation of the students. For example, if the teacher considers that CVWs facilitate *much* the creation of new school activities and has the master then the use of technology facilitates *much* the participation of the students.

MOOCs

Various authors (e.g., De-Castaneda et al., 2015; Guo & Zhang, 2017; Moore & Wang, 2021) mention that MOOCs facilitate the assimilation of knowledge and development of skills under the distance modality. In particular, 44.44% of the teachers (n = 24) think that MOOCs facilitate *very much* the creation of new school activities. Also, MOOCs facilitate *much* (n = 11, 20.37%) the creation of new school activities. Consequently, the majority of the teachers (64.81%) have a favorable opinion about this technological tool.

As mentioned by Taranto et al. (2020), the incorporation of MOOCs in the educational field facilitates the teaching-learning process at any time. The results of machine learning about H3 are higher than 0.190, therefore, MOOCs positively influence the learning of the students. Consequently, the teachers at the National Autonomous University of Mexico consider that this technological tool improves the teaching-learning conditions during the COVID-19 pandemic.

Data science identified 8 conditions of the PM3 where the age and sex of the teacher determine how MOOCs influence the learning. In fact, the decision tree technique presents 4 conditions where the use of technology facilitates *very much* the learning of the students. For example, if the teacher considers that

MOOCs facilitate *very much* the creation of new school activities and has an age > 47 years then the use of technology facilitates *very much* the learning of the students.

Also, data science presents 2 conditions where the use of technology facilitates *much* the learning of the students. For example, if the teacher considers that MOOCs facilitate *much* the creation of new school activities and has an age > 47 years then the use of technology facilitates *much* the learning of the students. Finally, this model presents 2 conditions where the use of technology facilitates *little* the learning of the students. For example, if the teacher considers that MOOCs facilitate *little* the creation of new school activities and is a man then the use of technology facilitates *little* the learning of the students.

Also, students use MOOCs to facilitate the assimilation of knowledge and actively participate during the teaching-learning process (De-Castaneda et al., 2015; Moore & Wang, 2021; Zhu et al., 2020). The results of machine learning about H4 are higher than 0.110, therefore, MOOCs positively influence the participation of the students. Consequently, this technological tool favors the teaching-learning conditions during the COVID-19 pandemic.

Data science identified 8 conditions of the PM4 where the age and educational level of the teacher determine how MOOCs influence the participation of the students. In fact, the decision tree technique presents 5 conditions where the use of technology facilitates *very much* the participation of the students. For example, if the teacher considers that MOOCs facilitate *very much* the creation of new school activities then the use of technology facilitates *very much* the participation of the students.

Also, data science presents 2 conditions where the use of technology facilitates *much* the participation of the students. For example, if the teacher considers that MOOCs facilitate *much* the creation of new school activities and has an age > 52.5 years then the use of technology facilitates *much* the participation of the students. Finally, this model presents 1 condition where the use of technology facilitates *little* the participation of the students. For example, if the teacher considers that MOOCs facilitate *little* the creation of new school activities and has the doctorate then the use of technology facilitates *little* the participation of the students.

CONCLUSION

Educational institutions are changing the teaching-learning process with the support of technological tools due to the emergence of COVID-19. In particular, the results of machine learning indicate that CVWs and MOOCs positively influence the learning and participation of the students.

This study recommends the incorporation of ICTs in the educational field because teachers can organize and carry out creative activities under the distance modality. In particular, educational institutions can include in their strategic planning the use of CVWs and MOOCs during the teaching-learning process.

The limitations of this research are the sample and analysis about the perception of the teachers in a Mexican university. Therefore, future research can analyze CVWs and MOOCs considering the development of skills and satisfaction of the students in the middle schools, high schools and universities.

The implications of this study allow that teachers use CVWs to facilitate the learning and promote the active role of the students through the exchange of ideas from any place. Likewise, the incorporation of MOOCs in the educational field facilitates the organization and realization of creative activities under the distance modality.

In conclusion, the COVID-19 pandemic is transforming the roles of the teachers and students during the educational process. Therefore, CVWs and MOOCs allow the construction of new virtual spaces in order to meet the educational demands in the 21st century.

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