Teachers' Perceptions about the Impact of Moodle in the Educational Field Considering Data Science

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ARTICLE INFO	ABSTRACT
	Today, Learning Management Systems (LMS) such as Moodle facilitate the teaching-learning process, promote the organization of creative activities from anywhere and allow the active participation of the students before, during and after the face-to-face sessions. The objective of this quantitative research is to analyze the teachers' perceptions about the impact of Moodle in the educational field considering data science and machine learning. The independent variable is the use of Moodle during the organization of new school activities and the dependent variables are the performance of the activities inside and outside the classroom and the participation and communication during the educational process. The participants are 70 teachers from the National Autonomous University of Mexico (UNAM). The results of machine learning (linear regression) indicate that Moodle positively influences the participation and communication during the educational process. Likewise, this LMS positively influences the performance of the activities inside and outside the classroom. In particular, Moodle allows improving the educational field through the realization of the online exams and discussion forums, diffusion of the tasks and consultation of the contents at any time. Data science identifies 3 predictive models on the impact of Moodle in the educational field. In fact, the decision tree technique establishes the conditions on the use of this LMS considering the characteristics of the teachers (sex and maximum degree of study). The implications of this research allow affirming that teachers have the opportunity to create, organize and carry out various creative and active activities through this LMS. Finally, teachers can use Moodle to update the activities of the courses and build new educational spaces that allow the active role of the students during the learning process. **Keywords:** Moodle, teaching, technology, data science, machine learning

INTRODUCTION

Educational institutions are using the Learning Management Systems (LMS) to facilitate the teaching-learning process from anywhere (Horvat et al., 2015; Salas-Rueda, 2020) and organize new school activities such as the realization of the online exams and discussion forums, diffusion of the tasks and consultation of the contents (Salas-Rueda, Salas-Rueda, & Salas-Rueda, 2020; Shah & Cheng, 2019; Then et al., 2016). For example, Moodle allows that students consult the resources and materials of the courses at home and office (Silva-Ordaz et al., 2016; Then et al., 2016).

Technological advances such as LMS, digital tools and web applications allow the active participation of the students before, during and after the face-to-face session (Dreamson et al., 2018; Kyzy, Ismailova, & Dundar, 2018; Salas-Rueda, 2019). In particular, Moodle facilitates the organization and realization of the online exams inside and outside the classroom (Al-Azawei, Baiee, & Mohammed, 2019; Jebari, Boussedra, & Ettouhami, 2017; Shdiafat & Obeidallah, 2019).

Even teachers can create new educational spaces through the use of the technology (Gutman, 2017; Jebari, Boussedra, & Ettouhami, 2017; Limongelli et al., 2016; Salas-Rueda & Lugo-García, 2019). For example, students have an active role during the teaching-learning process through the realization of the discussion forums in Moodle (Rehatschek, Holzl, & Fladischer, 2011).

LMS have a fundamental role in the educational field because teachers organize the student-centered activities (González, Pintor-Chávez, & Gómez-Zermeño, 2016; Romero-Díaz, Sola-Martínez, & Trujillo-Torres, 2015; Veytia-Bucheli & Leyva-Ortiz, 2016). In fact, Moodle facilitate the interaction and communication between the students during the realization of the distance courses (González, Pintor-Chávez, & Gómez-Zermeño, 2016; Romero-Díaz, Sola-Martínez, & Trujillo-Torres, 2015; Vidrio-Talavera, Gómez-Zermeño, & Zambrano-Izquierdo, 2015).

Even, LMS facilitate the dissemination of the audiovisual contents and consultation of the information of the courses at any time (Cobanoglu, 2018; Kotama, Saputra, & Linawati, 2019; Tumbleson, 2016). The use of mobile devices in the educational field allows the consultation of the videos and carrying out of the activities in Moodle (Aikina & Bolsunovskaya, 2020).

LMS such as Moodle are changing the interaction, communication and roles of teachers and students during the educational process (Islam, 2015; Mafuna & Wadesango, 2016; Oskouei & Kor, 2017). In fact, educational institutions are promoting the use of LMS in order to facilitate the active role of students. In particular, Moodle has a web interface that is easy to use and free.

Therefore, this quantitative research aims to analyze the teachers' perceptions about the impact of Moodle in the educational field considering data science and machine learning. The research questions are:

- How does the use of Moodle influence the participation and communication during the educational process?
- How does the use of Moodle influence the performance of the activities inside the classroom?
- How does the use of Moodle influence the performance of the activities outside the classroom?

LEARNING MANAGEMENT SYSTEM

The use of LMS in the educational field allows that teachers organize new school activities such as the realization of the online exams and discussion forums, review of the digital presentations and consultation of the course information at any time (Rehatschek, Holzl , & Fladischer, 2011; Veytia-Bucheli & Leyva-Ortiz, 2016; Vidrio-Talavera, Gómez-Zermeño, & Zambrano-Izquierdo, 2015). In particular, Moodle improved the teaching-learning conditions in the courses of Engineering (Aikina & Bolsunovskaya, 2020), Computer science (Al-Azawei, Baiee, & Mohammed, 2019), Information Systems Management (Jebari, Boussedra, & Ettouhami, 2017), Mechatronics (Ferreira & Cardoso, 2005), Management System (El-Seoud, Ahmad, & El-Sofany, 2009), Computer Science (Vidrio-Talavera, Gómez-Zermeño, & Zambrano-Izquierdo, 2015) and Education (Veytia-Bucheli & Leyva-Ortiz, 2016).

In the 21st century, teachers are creating new learning spaces by incorporating LMS in the school activities (Al-Azawei, Baiee, & Mohammed, 2019; Kotama, Saputra, & Linawati, 2019). For example, Moodle was used to improve the teaching-learning conditions through the use of the video games (Kotama, Saputra, & Linawati, 2019).

Teachers can organize and realize creative activities in the LMS (Aikina & Bolsunovskaya, 2020; Shdiafat & Obeidallah, 2019; Veytia-Bucheli & Leyva-Ortiz, 2016). In particular, students use Moodle to solve the online exams from anywhere (Jebari, Boussedra, & Ettouhami, 2017; Shdiafat & Obeidallah, 2019). In fact, this LMS immediately sends the feedback and results of the online exams (Al-Azawei, Baiee, & Mohammed, 2019; El-Seoud, Ahmad, & El-Sofany, 2009; Shdiafat & Obeidallah, 2019).

In courses of Engineering, Moodle increased the motivation of the students and academic performance (Aikina & Bolsunovskaya, 2020). Even the use of the mobile devices in the educational field facilitated the access to the school contents and realization of the activities in Moodle (Aikina & Bolsunovskaya, 2020). Likewise, the feedback of the activities in Moodle improved the assimilation of the knowledge in the field of engineering (Aikina & Bolsunovskaya, 2020).

LMS allows that students view the information of the courses at any time (Aikina & Bolsunovskaya, 2020; Jebari, Boussedra, & Ettouhami, 2017; Veytia-Bucheli & Leyva-Ortiz, 2016). In fact, the students of the Basic Programming course actively participated during the teaching-learning process through the realization of the online exams in Moodle (Al-Azawei, Baiee, & Mohammed, 2019). Furthermore, this LMS allows the creation of the interactive spaces that facilitate the learning process about programming (Al-Azawei, Baiee, & Mohammed, 2019).

In the course of the Information Systems Management, Moodle facilitated the personalization of the learning process through the review of the information and realization of the online exams (Jebari, Boussedra, & Ettouhami, 2017). Likewise, this LMS improved the communication between the participants of the educational process through the use of the chat (Jebari, Boussedra, & Ettouhami, 2017).

LMS allow the access to the virtual laboratories in order to facilitate the assimilation of knowledge (Ferreira & Cardoso, 2005). For example, the students of Mechatronics developed their skills through the simulations in Moodle (Ferreira & Cardoso, 2005). Likewise, this LMS facilitated the performance of the experiments through the virtual laboratories (Ferreira & Cardoso, 2005).

In the course of Management System, Moodle facilitated the active role of the students through the consultation of the information, realization of the discussion forums and resolution of the online exams (El-Seoud, Ahmad, & El-Sofany, 2009). In addition, this LMS facilitated the delivery of the assignments from anywhere and consultation of the grades at any time (El-Seoud, Ahmad, & El-Sofany, 2009). Even Moodle increased the motivation of the students through the use of the technological applications (El-Seoud, Ahmad, & El-Sofany, 2009).

Moodle transforms the teaching-learning process in the 21st century because this LMS facilitates the participation of the students during the teaching-learning process through the realization of the online exams (Al-Azawei, Baiee, & Mohammed, 2019; Jebari, Boussedra, & Ettouhami, 2017; Shdiafat & Obeidallah, 2019), consultation of the contents (Aikina & Bolsunovskaya, 2020; Vidrio-Talavera, Gómez-Zermeño, & Zambrano-Izquierdo, 2015), revision of the information (Jebari, Boussedra, & Ettouhami, 2017), realization of the forums discussion (El-Seoud, Ahmad, & El-Sofany, 2009; Jebari, Boussedra, & Ettouhami, 2017; Veytia-Bucheli & Leyva-Ortiz, 2016), use of the technological applications (Ferreira & Cardoso, 2005) and delivery of the tasks (El-Seoud, Ahmad, & El-Sofany, 2009; Veytia-Bucheli & Leyva-Ortiz, 2016; Vidrio-Talavera, Gómez-Zermeño, & Zambrano-Izquierdo, 2015).

Teachers use LMS to achieve the innovation in the educational field (Veytia-Bucheli & Leyva-Ortiz, 2016). For example, the students of Education used Moodle to facilitate the assimilation of knowledge in the course of Literary Appreciation (Veytia-Bucheli & Leyva-Ortiz, 2016). In fact, the incorporation of Moodle in the school activities increased the motivation of the students (Veytia-Bucheli & Leyva-Ortiz, 2016). In the course of Literary Appreciation, Moodle allowed the participation of the forums, delivery of the assignments, download of the materials and realization of the online exams (Veytia-Bucheli & Leyva-Ortiz, 2016).

In the course of Computer Science, Moodle facilitated the learning process and development of the technological skills by taking the online exams and delivering the tasks (Vidrio-Talavera, Gómez-Zermeño, & Zambrano-Izquierdo, 2015). The results about the use of this LMS in the course of Informatics are the increase in the motivation of the students and improvement of the academic performance (Vidrio-Talavera, Gómez-Zermeño, & Zambrano-Izquierdo, 2015).

Finally, LMS such as Moodle allows the construction of the interactive spaces that facilitate the dissemination of the school contents, collaboration and communication between the participants of the educational process (Aikina & Bolsunovskaya, 2020; Romero-Díaz, Sola-Martínez, & Trujillo-Torres, 2015; Silva-Ordaz et al., 2016). Even the use of Moodle in the universities is increasing due to this LMS is easy to use (Aikina & Bolsunovskaya, 2020; Shdiafat & Obeidallah, 2019; Silva-Ordaz et al., 2016).

Table 1. Questionnaire about the impact of Moodle in the educational field

No.	Variable	Dimension	Question	Answer	n	%
1	Teachers	Sex	1. Indicate your sex	Man	36	51.43%
				Woman	34	48.57%
		Maximum degree of study	2. Indicate your maximum degree of study	Bachelor	19	27.14%
				Master	33	47.14%
				Doctorate	18	25.71%
2	Technology in the educational field	Moodle	3. Moodle facilitates the organization of new school activities	Too little (1)	1	1.43%
				Little (2)	14	20.00%
				Much (3)	27	38.57%
				Too much (4)	28	40.00%
		Participation and communication	4. The use of the technology facilitates the participation and communication during the educational process	Too little (1)	1	1.43%
				Little (2)	7	10.00%
				Much (3)	26	37.14%
				Too much (4)	36	51.43%
		Activities inside the classroom	5. The performance of the activities inside the classroom through technology is	Very rare (1)	7	10.00%
				Rare (2)	27	38.57%
				Frequent (3)	21	30.00%
				Very frequent (4)	15	21.43%
		Activities outside the classroom	6. The performance of the activities outside the classroom through technology is	Very rare (1)	3	4.29%
				Rare (2)	18	25.71%
				Frequent (3)	26	37.14%
				Very frequent (4)	23	32.86%

METHODOLOGY

The objective of this quantitative research is to analyze the teachers' perceptions about the impact of Moodle in the educational field considering data science and machine learning.

Participants

The participants are 70 teachers (36 men and 34 women) from the National Autonomous University of Mexico (UNAM) who took the "Classroom of the Future 2020" Diploma. This diploma is financed by PAPIME projects (Program Support for Projects to Innovate and Improve the Education): PE106420, PE102920, PE106419, PE314819, PE306619 and PE104720 in order to improve the teaching-learning conditions considering the aspects of pedagogy and technology.

The research hypotheses about the impact of Moodle in the educational field are:

- Hypothesis 1 (H1): Moodle positively influences the participation and communication during the educational process
- Hypothesis 2 (H2): Moodle positively influences the performance of the activities inside the classroom
- Hypothesis 3 (H3): Moodle positively influences the performance of the activities outside the classroom

Data Collection

Table 1 shows the questionnaire used to collect the information on the impact of Moodle in the educational field.

Data Analysis

The Rapidminer tool allows building the predictive models through the decision tree technique and calculation of machine learning to evaluate the hypotheses about the impact of Moodle in the educational field.

In machine learning, the training section (50%, 60% and 70% of the sample) allows calculating the linear regressions and evaluation section (50%, 40% and 30% of the sample) allows identifying the accuracy of these linear regressions.

Table 2. Results of machine learning (linear regression)

| Hypothesis	Training	Linear regression	Conclusion	Squared error
H1: Moodle → participation and communication during the educational process	50%	y = 0.420x + 2.755	Accepted: 0.420	0.391
	60%	y = 0.454x + 2.558	Accepted: 0.454	0.364
	70%	y = 0.447x + 2.567	Accepted: 0.447	0.429
H2: Moodle → performance of the activities inside the classroom	50%	y = 0.110x + 3.204	Accepted: 0.110	1.020
	60%	y = 0.181x + 2.909	Accepted: 0.181	0.906
	70%	y = 0.224x + 2.731	Accepted: 0.224	1.043
H3: Moodle → performance of the activities outside the classroom	50%	y = 0.164x + 3.437	Accepted: 0.164	0.711
	60%	y = 0.132x + 3.422	Accepted: 0.132	0.523
	70%	y = 0.207x + 3.148	Accepted: 0.207	0.478
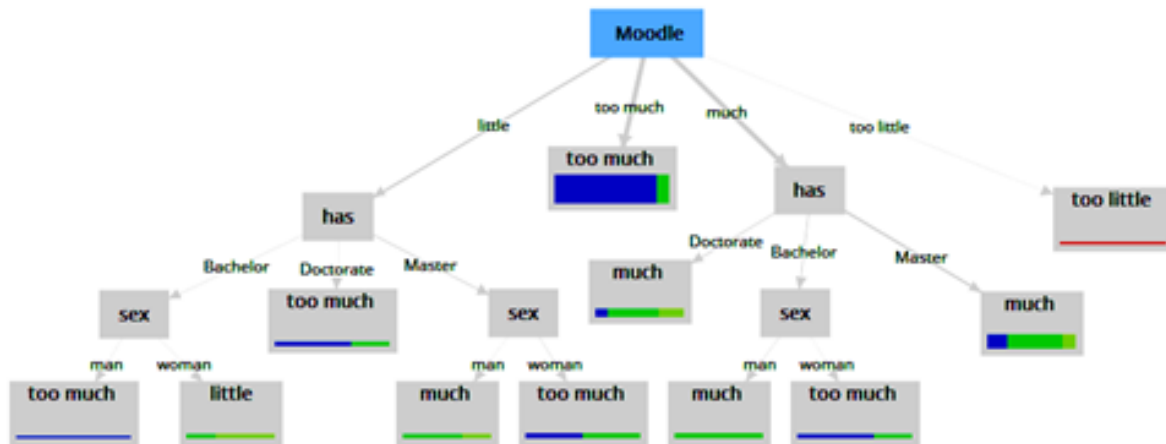
Figure 1. Predictive Model 1 on the impact of Moodle

Data science allows building the predictive models through the use of the Rapidminer tool. The information about the maximum degree of study and sex of the teachers, Moodle, participation and performance of the activities is used to build the predictive models through the decision tree technique.

RESULTS

Moodle facilitates too much (n = 28, 40.00%), much (n = 27, 38.57%), little (n = 14, 20.00%) and too little (n = 1, 1.43%) the organization of new school activities (See **Table 1**). Likewise, the results of machine learning with 50%, 60% and 70% of training indicate that H1, H2, H3 are accepted (See **Table 2**).

Participation and Communication during the Educational Process

The use of the technology facilitates too much (n = 36, 51.43%), much (n = 26, 37.14%), little (n = 7, 10.00%) and too little (n = 1, 1.43%) the participation and communication during the educational process (See **Table 1**). The results of machine learning with 50% (0.420), 60% (0.454) and 70% (0.447) indicate that H1 is accepted (See **Table 2**). Therefore, Moodle positively influences the participation and communication during the educational process.

Figure 1 shows the Predictive Model 1 on the impact of Moodle in the educational field. For example, if the teacher considers that Moodle facilitates much the organization of new school activities and the maximum degree of study is Doctorate then the use of the technology facilitates much the participation and communication during the educational process. On the other hand, if the teacher considers that Moodle facilitates little the organization of new school activities, is a woman and the maximum degree of study is Bachelor then the use of the technology facilitates little the participation and communication during the educational process.

Table 3 shows the 11 conditions of the Predictive Model 1. For example, if the teacher considers that Moodle facilitates much the organization of new school activities and the maximum degree of study is Master

Table 3. Conditions of the Predictive Model 1

| No.	Moodle → organization of new school activities	Sex	Maximum degree of study	Use of the technology → participation and communication
1	Too much	-	-	Too much
2	Much	-	Doctorate	Much
3	Much	-	Master	Much
4	Much	Man	Bachelor	Much
5	Much	Woman	Bachelor	Too much
6	Little	-	Doctorate	Too much
7	Little	Man	Master	Much
8	Little	Woman	Master	Too much
9	Little	Man	Bachelor	Too much
10	Little	Woman	Bachelor	Little
11	Too little	-	-	Too little
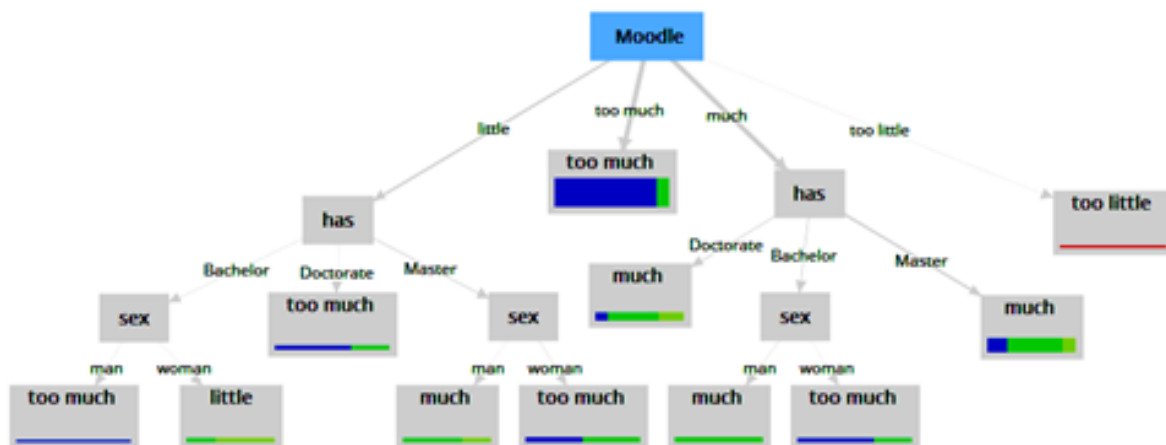
Figure 2. Predictive Model 2 on the impact of Moodle

then the use of the technology facilitates much the pardticipation and communication during the educational process.

Performance of the Activities inside the Classroom

Table 1 indicates that the performance of the activities inside the classroom through technology is very frequent (n = 15, 21.43%), frequent (n = 21, 30.00%), rare (n = 27, 38.57%) and very rare (n = 7, 10.00%). The results of machine learning with 50% (0.110), 60% (0.181) and 70% (0.224) indicate that H2 is accepted (See **Table 2**). Therefore, Moodle positively influences the performance of the activities inside the classroom.

Figure 2 shows the Predictive Model 2 on the impact of Moodle in the educational field. For example, if the teacher considers that Moodle facilitates too much the organization of new school activities and the maximum degree of study is Doctorate then the performance of the activities inside the classroom through technology is frequent. On the other hand, if the teacher considers that Moodle facilitates little the organization of new school activities and the maximum degree of study is Doctorate then the performance of the activities inside the classroom through technology is frequent.

Table 4 shows the 8 conditions of the Predictive Model 2. For example, if the teacher considers that Moodle facilitates too much the organization of new school activities and the maximum degree of study is Bachelor then the performance of the activities inside the classroom through technology is very frequent.

Table 4. Conditions of the Predictive Model 2

No.	Moodle → organization of new school activities	Sex	Maximum degree of study	Moodle → activities inside the classroom
1	Too much	-	Doctorate	Frequent
2	Too much	-	Master	Frequent
3	Too much	-	Bachelor	Very frequent
4	Much	-	-	Rare
5	Little	-	Doctorate	Frequent
6	Little	-	Master	Very frequent
7	Little	-	Bachelor	Rare
8	Too little	-	-	Very rare
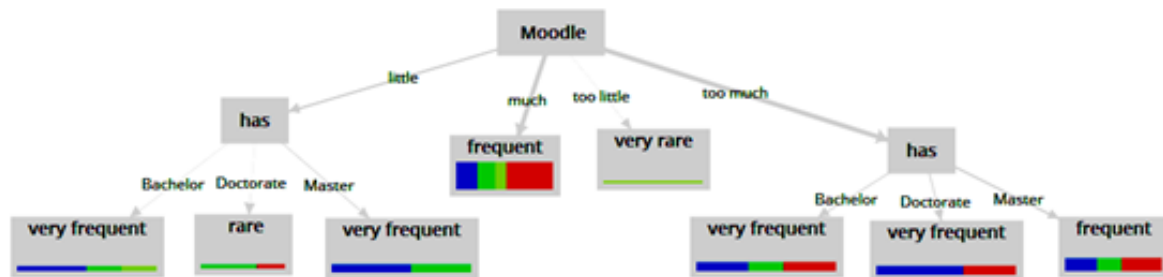
Figure 3. Predictive Model 3 on the impact of Moodle

Table 5. Conditions of the Predictive Model 3

No.	Moodle → organization of new school activities	Sex	Maximum degree of study	Moodle → activities outside the classroom
1	Too much	-	Doctorate	Very frequent
2	Too much	-	Master	Frequent
3	Too much	-	Bachelor	Very frequent
4	Much	-	-	Frequent
5	Little	-	Doctorate	Rare
6	Little	-	Master	Very frequent
7	Little	-	Bachelor	Very frequent
8	Too little	-	-	Very rare

Performance of the Activities outside the Classroom

Table 1 indicates that the performance of the activities outside the classroom through technology is very frequent (n = 23, 32.86%), frequent (n = 26, 37.14%), rare (n = 18, 25.71%) and very rare (n = 3, 4.29%). Likewise, the results of machine learning with 50% (0.164), 60% (0.132) and 70% (0.207) indicate that H3 is accepted (See **Table 2**). Therefore, Moodle positively influences the performance of the activities outside the classroom.

Figure 3 shows the Predictive Model 3 on the impact of Moodle in the educational field. For example, if the teacher considers that Moodle facilitates too much the organization of new school activities and the maximum degree of study is Doctorate then the performance of the activities outside the classroom through technology is very frequent. On the other hand, if the teacher considers that Moodle facilitates little the organization of new school activities and the maximum degree of study is Doctorate then the performance of the activities outside the classroom through technology is rare.

Table 5 shows the 8 conditions of the Predictive Model 3. For example, if the teacher considers that Moodle facilitates too much the organization of new school activities and the maximum degree of study is Master then the performance of the activities outside the classroom through technology is frequent.

DISCUSSION

This research shares the ideas of various authors (e.g., Aikina & Bolsunovskaya, 2020; Al-Azawei, Baiee, & Mohammed, 2019; Jebari, Boussedra, & Ettouhami, 2017) about the importance of using Moodle to transform

the teaching-learning process. Most of the teachers (n = 28, 40.00%) think that Moodle facilitates too much the organization of new school activities.

Participation and Communication during the Educational Process

Moodle improved the communication (Jebari, Boussedra, & Ettouhami, 2017) and participation (Al-Azawei, Baiee, & Mohammed, 2019; Shdiafat & Obeidallah, 2019) during the educational process.

Most of the teachers (n = 36, 51.43%) think that the use of the technology facilitates too much the participation and communication during the educational process. Likewise, the results of machine learning on H1 are higher than 0.419, therefore, Moodle positively influences the participation and communication during the educational process. Data science identifies 11 conditions of the Predictive Model 1. In fact, the decision tree technique establishes the conditions on the use of this LMS considering the characteristics of the teachers (sex and maximum degree of study). For example, if the teacher considers that Moodle facilitates much the organization of new school activities and the maximum degree of study is Doctorate then the use of the technology facilitates much the participation and communication during the educational process.

Performance of the Activities inside the Classroom

Veytia-Bucheli and Leyva-Ortiz (2016) explain that the use of Moodle in face-to-face sessions and outside the classroom allows creating new learning spaces. Most of the teachers (n = 27, 38.57%) think that the performance of the activities inside the classroom through technology is rare. Likewise, the results of machine learning on H2 are greater than 0.100, therefore, Moodle positively influences the performance of the activities inside the classroom. Data science identifies 8 conditions of Predictive Model 2 through the decision tree technique. For example, if the teacher considers that Moodle facilitates too much the organization of new school activities and the maximum degree of study is Doctorate then the performance of the activities inside the classroom through technology is frequent.

Performance of the Activities outside the Classroom

Aikina and Bolsunovskaya (2020) mention that Moodle allows the organization and realization of various activities such as the consultation of the multimedia resources and delivery of the tasks at any time.

Most of the teachers (n = 26, 37.14%) think that the performance of the activities outside the classroom through technology is frequent. Likewise, the results of machine learning on H3 are greater than 0.130, therefore, Moodle positively influences the performance of the activities outside the classroom. Data science identifies 8 conditions of the Predictive Model 3 through the decision tree technique. For example, if the teacher considers that Moodle facilitates too much the organization of new school activities and the maximum degree of study is Doctorate then the performance of the activities outside the classroom through technology is very frequent.

CONCLUSION

Teachers use technology to facilitate the learning process, create new educational spaces and improve the organization of the courses. For example, Moodle positively influences the participation and communication during the educational process. In fact, this LMS allows the realization of discussion forums and delivery of tasks from anywhere.

Technological advances allow innovating the educational process, improving the learning conditions and facilitating the interaction between the teachers, students and school contents. In particular, Moodle positively influences the performance of the activities inside and outside the classroom. Teachers use this LMS to promote the active participation of students by consulting the information and taking the exams online at any time.

The limitations of this research are the analysis about the impact of Moodle in the educational field and perceptions of the teachers in a university. Therefore, future research may analyze the impact of LMS such as Canvas, Schoology and Blackboard at various universities.

This research recommends the incorporation of Moodle in the educational field to create virtual learning spaces that increase the motivation and satisfaction of the students and facilitate the performance of active

activities at any time and from anywhere. Also, the implications of this research allow affirming that teachers have the opportunity to create, organize and carry out various creative and active activities through this LMS.

Teachers are changing the organization of the school activities, communication, interaction and behavior of the students through the use of the technology. For example, Moodle facilitates the participation and communication during the educational process and performance of the activities inside and outside the classroom.

ACKNOWLEDGEMENTS

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