ANALYSIS OF THE WEB APPLICATION ON BAYES' THEOREM CONSIDERING DATA SCIENCE AND TECHNOLOGICAL ACCEPTANCE MODEL

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ABSTRACT

This mixed research aims to design and implement the Web Application on Bayes' Theorem (WABT) in the Statistical Instrumentation for Business subject. WABT presents the procedure to calculate the probability of Bayes' Theorem through the simulation of data about the supply of products. Technology Acceptance Model (TAM), machine learning and data science are used to analyze the impact of WABT on the educational process. The results of machine learning (60%, 70% and 80% of training) indicate that WABT positively influences the Motivation, Autonomy, Personalized learning and Active role. Data science identifies predictive models of the impact of WABT on the teaching and learning process through the decision tree technique. In addition, WABT is a pleasant, simple, useful and innovative web tool for the educational field. Finally, teachers can use TAM model, data science and machine learning in order to identify the impact of digital tools on the educational process.

Keywords: Technology, learning, TAM model, data science, learning machine.

INTRODUCTION

The planning and organization of school activities in the 21st century are being modified due to the emergence of the new information and communication technologies (Abbott, 2016; Aparicio, Bacao, & Oliveira, 2016; Guerrero & Noguera, 2018). In particular, universities are identifying their strengths, opportunities, weaknesses and threats in order to innovate the educational context through technology (Salas & Salas, 2018; Tikoria & Agariya, 2017). The education system must modify the teaching-learning process in order to meet the expectations and demands of the Society, that is, students need to develop their skills and acquire an active role through digital tools (Fernandez, 2017; Marquez & Mourelle, 2018). Also, technology and learning methods improve knowledge assimilation, autonomy and motivation (Emelyanova & Voronina, 2017; Salas & Vazquez, 2017).

Advances of the internet are causing that educational institutions design, organize and use websites (Alvarez & Garcia, 2017; Sun, Xie, & Anderman, 2018). Therefore, Information and Communication Technologies (ICT) are transforming the functions and roles of students and teachers in the educational field (Murphy & Stewart, 2017; Roberts, 2018; Salas, 2019; Tejada & Pozos, 2018). For example, teachers need to develop digital competence in order to plan, design and build new teaching-learning environments (Tejada & Pozos, 2018). The incorporation of technological applications in school activities allows the innovation of teaching-learning methods and processes (Kryukov & Gorin, 2017; Lawrence, 2018). Even, the universities are identifying, selecting and using new strategies with the purpose of raising the educational quality (Diep, Cocquyt, Zhu, Vanwing, & Greef, 2017; Fernandez, 2017; Lee, 2010).

Due to the advancement of technology, various models have emerged on the impact, perception and influence of digital tools in the educational context (Kurt & Tingoy, 2017). In particular, TAM model describes the degree of acceptance about the use of technology in organizations through the beliefs, behaviors and intentions of individuals (Chow, Herold, Choo, & Chan, 2012; Kurt & Tingoy, 2017; Liu, Chen, Sun, Wible, & Kuo, 2010).

The students of the Statistical Instrumentation for Business subject have problems to assimilate the knowledge related to Bayes' theorem.Therefore, this mixed research proposes the construction of WABT in order to improve the teaching-learning process on the Bayes' theorem. Also, TAM model, machine learning and data science allow knowing the impact of this web application in the Statistical Instrumentation for Business subject.

The research questions are:

- What is the impact of WABT in the Statistical Instrumentation for Business subject considering machine learning (60%, 70% and 80% of training)?
- How does the use of WABT influence the teaching-learning process considering TAM model?
- What are the perceptions of the students about the incorporation of WABT in the educational process on Bayes' theorem?
- What are the predictive models about the use of WABT in the educational process by means of the decision tree technique (data science)?

TECHNOLOGY ACCEPTANCE MODEL

New information and communication technologies are changing the organization and realization of activities in the educational field (Baleghi, Ayub, Mahmud, & Daud, 2017; Salas, 2016). In fact, the use of digital tools is increasing in the classroom in order to achieve the development of skills (Bortnik, Stozhko, Pervukhina, Tchernysheva, & Belysheva, 2017). According to Doleck, Bazelais and Lemay (2017), there are several models that analyze the intention and perception of individuals about the use of technology in organizations, for example, Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB) and Unified Theory of Acceptance and Use of Technology (UTAUT).

TAM model allows analyzing the factors that influence the educational process during the use of information systems (Baleghi, Ayub, Mahmud, & Daud, 2017; Fong, Lee, Chang, Zhang, Ngaia, & Lim, 2014). In 1986, Davis proposed this model considering mainly the aspects on Perceived Ease of Use (PEU) and Perceived Usefulness (PU) of the technological applications (Baleghi, Ayub, Mahmud, & Daud, 2017; Chow, Herold, Choo, & Chan, 2012; Ngai, Poon, & Chan, 2007).

Perceived Usefulness is related to the effect of technology on user performance and Perceived Ease of Use refers to the use of technology without effort (Baleghi, Ayub, Mahmud, & Daud, 2017; Teo, Lee, Chai, & Wong, 2009). In the field of education, Perceived Usefulness is the perception of students about the use of ICT to achieve the development of competencies (Baleghi, Ayub, Mahmud, & Daud, 2017). In addition, TAM model proposed by Davis includes external variables, attitudes and intentions (Baleghi, Ayub, Mahmud, & Daud, 2017; Liu, Chen, Sun, Wible, & Kuo, 2010).

Several authors (e.g., Baleghi, Ayub, Mahmud, & Daud, 2017; Chen & Chengalur, 2015; Doleck, Bazelais, & Lemay, 2017) have used TAM model to analyze the impact of the tools of information and communication in the teaching-learning process. For example, Baleghi, Ayub, Mahmud and Daud (2017) propose the use of TAM model to analyze the interactivity, technical support, ease of use and usefulness of the Learning Management System (LMS) in the universities.

Also, Doleck, Bazelais and Lemay (2017) propose the use of TAM model to analyze the ease of use (effectiveness and satisfaction) and utility (peer influence and relative advantage) of social networks in the educational context. Finally, TAM model determines the degree of acceptance related to the use of technology in organizations (Cabero, Gallego, Puentes, & Jimenez, 2018).

METHOD

The objective of this mixed research is to analyze the impact of WABT on the educational process considering TAM model, data science and machine learning. WABT presents the procedure to calculate the probability of the Bayes' theorem through the simulation of data about the supply of products by companies.

Participants

This mixed research was done in a Mexican university during the 2018 school year. The participants are 61 students of the Statistical Instrumentation for Business subject (See Table 1).

Table 1. Research participants

Bachelor's degree	Number of students	Average age
Administration	9	18.66
Commerce	19	18.78
Accountancy	15	18.86
Marketing	16	18.93
Information Technology	2	19.00

Procedure

The procedure of this study began with the design and construction of WABT with the purpose of facilitating the teaching-learning process on Bayes' Theorem through the simulation of data about the supply of products by companies. Figure 1 shows the elements of this web application.

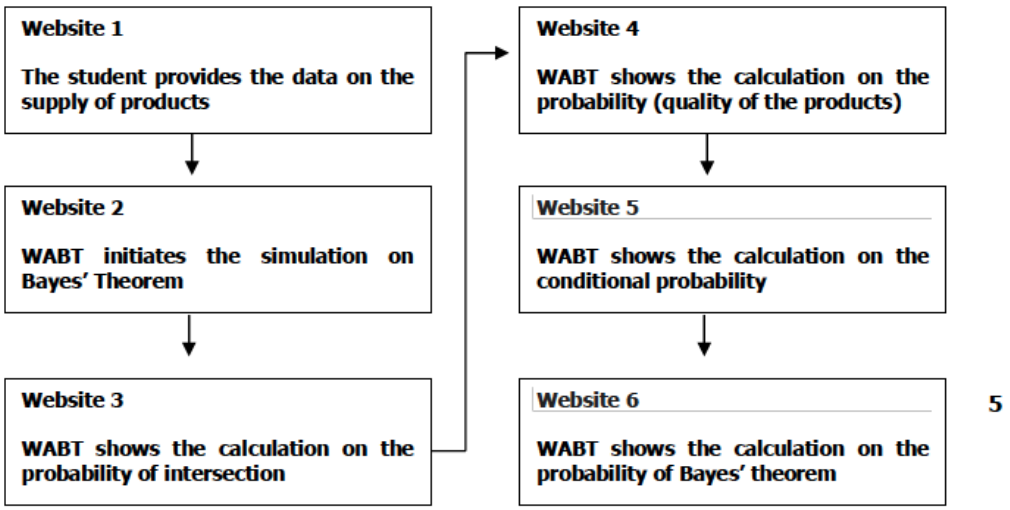

Figure 1. Elements of WABT

WABT asks for information of the probability on the supply of products: quality (good and poor) and providers (company 1 and company 2). Figure 2 shows the home page on WABT.

Figure 2. Web interface in WABT

To perform the calculation of Bayes' theorem, the probabilities of events (company 1 and company 2) and conditional probabilities (supply of the products) are necessary (See Figure 3).

Figure 3. Calculation of probabilities in WABT

Figure 4 shows the calculation on the probabilities of the intersection about the quality (good and poor) and providers (company 1 and company 2) in WABT.

Figure 4. Calculation on the probability of intersection in WABT

WABT shows the calculation of the probabilities on the good and poor quality of the products (See Figure 5).

Figure 5. Probability on the good and poor quality of the products in WABT

To calculate the Bayes' theorem, the probabilities of the intersections and quality of the products (good and poor) are necessary (See Figure 6).

Figure 6. Probability of Bayes' theorem (good quality of the products)

Figure 7 shows the probability of Bayes' theorem on poor quality of the products.

Figure 7. Probability of Bayes' theorem (poor quality of the products)

The students of the Statistical Instrumentation for Business subject used WABT through the following web address:

http://sistemasusables.com/estadisticaavanzada/sistema4/inicio.html

This study proposes the development of a model to analyze the use of WABT in the educational process on Bayes' theorem considering TAM model (See Figure 8).

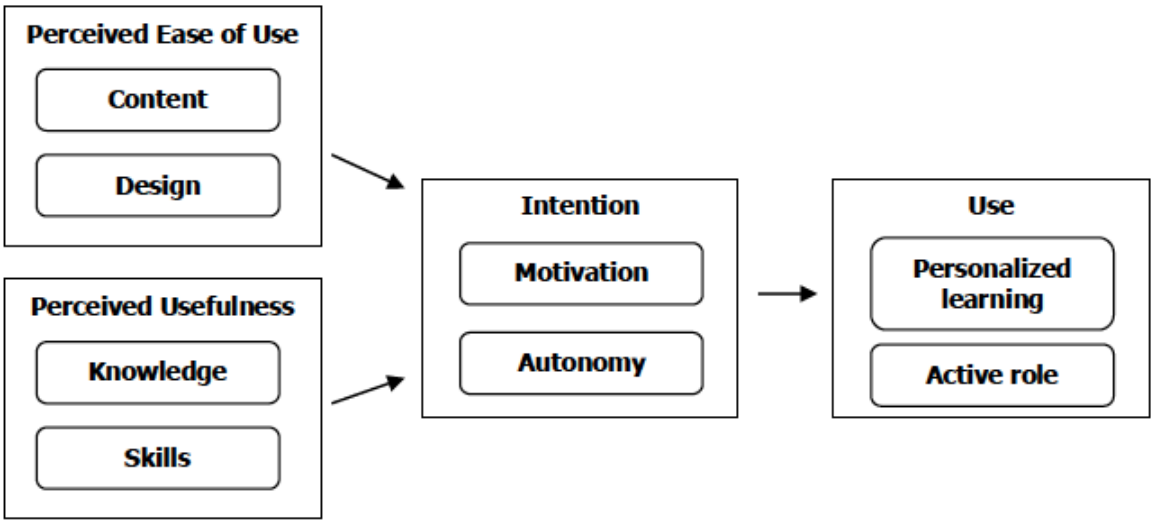

Figure 8. Use of TAM model in this research

Table 2 shows the elements of TAM model used in this research.

Table 2. TAM model

Item	TAM model	Dimension	Description
1	Perceived Ease of Use	Content of WABT	Simulation of data about the supply of products by companies
		Design of WABT	Aesthetics of the web interface (color, font, images and distribution of objects)
2	Perceived Usefulness	Knowledge	Assimilation of knowledge about the Bayes' theorem through WABT
		Skills	Development of mathematical skills on Bayes' theorem through WABT
3	Intention	Motivation	Positive attitude for learning through WABT
		Autonomy	Ability to organize learning through WABT
4	Use	Personalized learning	Management of learning through WABT
		Active role	Participation in learning through WABT

The hypotheses of this research related to the aspects of Intention and Perceived ease of use are:

H1: The content of WABT positively influences the motivation of the student during the learning process

H2: The design of WABT positively influences the motivation of the student during the learning process

H3: The content of WABT positively influences the autonomy of the student during the learning process

H4: The design of WABT positively influences the autonomy of the student during the learning process

Also, the hypotheses about Intention and Perceived Usefulness are:

H5: The assimilation of knowledge through WABT positively influences the motivation of the student during the learning process

H6: The development of skills through WABT positively influences the motivation of the student during the learning process

H7: The assimilation of knowledge through WABT positively influences the autonomy of the student during the learning process

H8: The development of skills through WABT positively influences the autonomy of the student during the learning process

The hypotheses about the Intention and Use of WABT during the teaching-learning process are:

H9: The motivation of the student positively influences personalized learning during the use of WABT

H10: The autonomy of the student positively influences personalized learning during the use of WABT

H11: The motivation of the student positively influences the active role for learning during the use of WABT

H12: The autonomy of the student positively influences the active role for learning during the use of WABT

The tools used in this research are Rapidminer tool and SPSS software. Rapidminer tool allows the construction of predictive models (decision tree technique) and calculation of linear regression by means of machine learning with 60%, 70% and 80% of training. On the other hand, SPSS software allows calculating Load factor, Cronbach's alpha and Average variance extracted in order to validate the measurement instrument.

Figure 9 shows the use of Rapidminer tool for calculating the linear regression (machine learning). Data Split component allows adjusting the training values (60%, 70% and 80%).

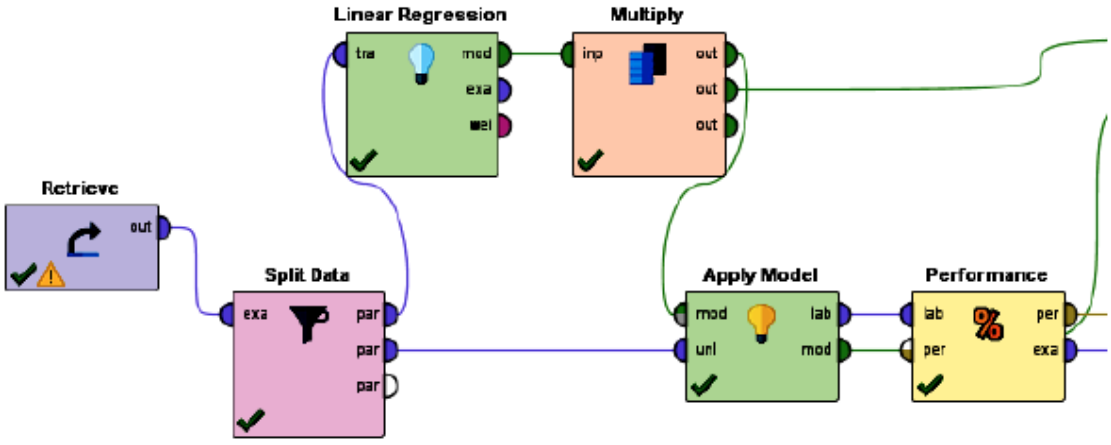

Figure 9. Use of Rapidminer tool for machine learning

The information on the elements of TAM model and the student profile (sex, age and Bachelor's degree) are used for the construction of the following predictive models on the impact of WABT in the motivation and autonomy during the educational process:

- Predictive model 1 on the content of WABT and motivation of the student during the learning process
- Predictive model 2 on the design of WABT and motivation of the student during the learning process
- Predictive model 3 on the content of WABT and autonomy of the student during the learning process
- Predictive model 4 on the design of WABT and autonomy of the student during the learning process

Also, the predictive models of Intention and Perceived Usefulness are:

- Predictive model 5 on the assimilation of knowledge through WABT and motivation of the student during the learning process
- Predictive model 6 on the development of skills through WABT and motivation of the student during the learning process
- Predictive model 7 on the assimilation of knowledge through WABT and autonomy of the student during the learning process
- Predictive model 8 on the development of skills through WABT and autonomy of the student during the learning process

The predictive models of the Intention and Use of WABT are:

- Predictive model 9 on the motivation of the student and personalized learning during the use of WABT
- Predictive model 10 on the autonomy of the student and personalized learning during the use of WABT
- Predictive model 11 on the motivation of the student and active role for learning during the use of WABT
- Predictive model 12 on the autonomy of the student and active role for learning during the use of WABT

Figure 10 shows the use of Rapidminer tool for the construction of predictive models on WABT in the educational process.

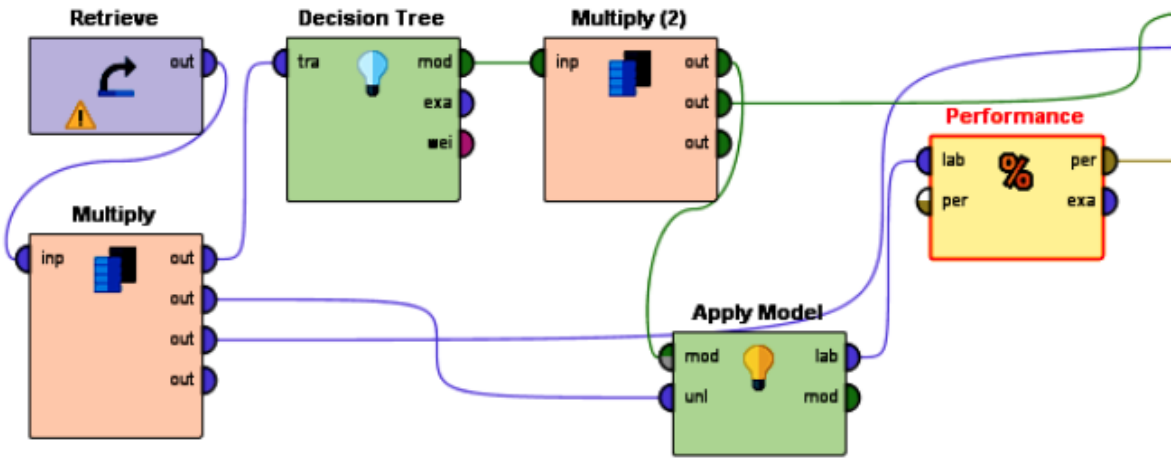

Figure 10. Use of Rapidminer tool for predictive models

Data Collection

Table 3 shows the measurement instrument used in this research. The scale used is Very much (1), Some (2), Little (3) and Too little (4).

Table 3. Measurement instrument

Variable	Dimension	Load factor	Cronbach's alpha	Average variance extracted
Perceived Ease of Use	Content	0.928	0.849	0.711
	Design	0.749		
Perceived Usefulness	Knowledge	0.913	0.814	0.816
	Skills	0.894		
Intention	Motivation	0.826	0.805	0.780
	Autonomy	0.937		
Use	Personalized learning	0.787	0.744	0.740
	Active role	0.928		

According to Pock (2007), the values must be higher than 0.60 in Cronbach's Alpha and 0.5 in Load factor to cover the reliability and validity requirements. Table 3 shows that all the variables meet these requirements.

Also, Average variance extracted must have a value greater than 0.5 (Pock, 2007). All the values are higher than 0.71 (See Table 3). The variables on the profile of the students are Sex, Age and Career. On the other hand, the qualitative variables are educational process, innovative tool, simulation, benefits, satisfaction and useful.

Analysis of Data

At the end of the topic on the Bayes' theorem, the measurement instrument is applied. Using SPSS software, the values on Load factor, Cronbach's alpha and Average variance extracted are calculated. Also, Rapidminer tool allows the construction of predictive models (decision tree technique) and calculation of linear regression by means of machine learning with 60%, 70% and 80% of training.

RESULTS

The results about the impact of WABT on the educational process are analyzed through machine learning and data science.

Perceived Ease of Use

The results of machine learning with 60% of training indicate that hypothesis 1 (0.394), hypothesis 2 (0.540), hypothesis 3 (0.672) and hypothesis 4 (0.606) are accepted (See Table 4).

Table 4. Machine learning about content and design of WABT (60% of training)

Hypothesis	Linear regression	Conclusion	Squared_error
H1: Content of WABT → Motivation	y = 0.394x + 0.866	Accepted: 0.394	0.296
H2: Design of WABT → Motivation	y = 0.540x + 0.663	Accepted: 0.540	0.185
H3: Content of WABT → Autonomy	y = 0.672x + 0.533	Accepted: 0.672	0.245
H4: Design of WABT → Autonomy	y = 0.606x + 0.601	Accepted: 0.606	0.177

Hypothesis 1, 2, 3 and 4 of WABT (Content and Design) are accepted through machine learning with 70% of training (See Table 5).

Table 5. Machine learning about content and design of WABT (70% of training)

Hypothesis	Linear regression	Conclusion	Squared_error
H1: Content of WABT → Motivation	y = 0.439x + 0.823	Accepted: 0.439	0.338
H2: Design of WABT → Motivation	y = 0.565x + 0.646	Accepted: 0.565	0.194
H3: Content of WABT → Autonomy	y = 0.710x + 0.470	Accepted: 0.710	0.321
H4: Design of WABT → Autonomy	y = 0.565x + 0.646	Accepted: 0.565	0.163

The results of machine learning with 80% of training indicate that hypothesis 1 (0.498), hypothesis 2 (0.610), hypothesis 3 (0.715) and hypothesis 4 (0.584) are accepted (See Table 6).

Table 6. Machine learning about content and design of WABT (80% of training)

Hypothesis	Linear regression	Conclusion	Squared_error
H1: Content of WABT → Motivation	y = 0.498x + 0.736	Accepted: 0.498	0.483
H2: Design of WABT → Motivation	y = 0.610x + 0.578	Accepted: 0.610	0.267
H3: Content of WABT → Autonomy	y = 0.715x + 0.473	Accepted: 0.715	0.414
H4: Design of WABT → Autonomy	y = 0.584x + 0.632	Accepted: 0.584	0.169

Figure 11 shows the predictive model 1. If the student considers that the content of WABT facilitates some the teaching-learning process and studies the Bachelor's degree in Administration (Adm) then this web application favors some the motivation of the student during the educational process on Bayes' theorem.

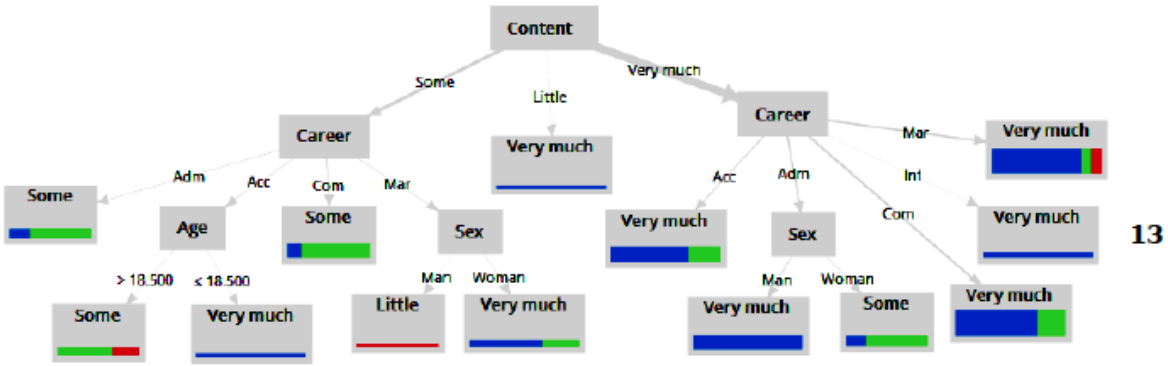

Figure 11. Predictive model 1

The accuracy of the predictive model 1 on the content of WABT and motivation of the student is 80.33% (See Figure 12).

accuracy: 80.33%

	true Very much	true Some	true Little	class precision
pred. Very much	35	7	1	81.40%
pred. Some	3	13	1	76.47%
pred. Little	0	0	1	100.00%
class recall	92.11%	65.00%	33.33%	

Figure 12. Accuracy of the predictive model 1

Figure 13 shows the predictive model 2. If the student considers that the design of WABT facilitates some the teaching-learning process, studies the Bachelor's degree in Marketing (Mar) and is woman then this web application favors very much the motivation of the student during the educational process on Bayes' theorem.

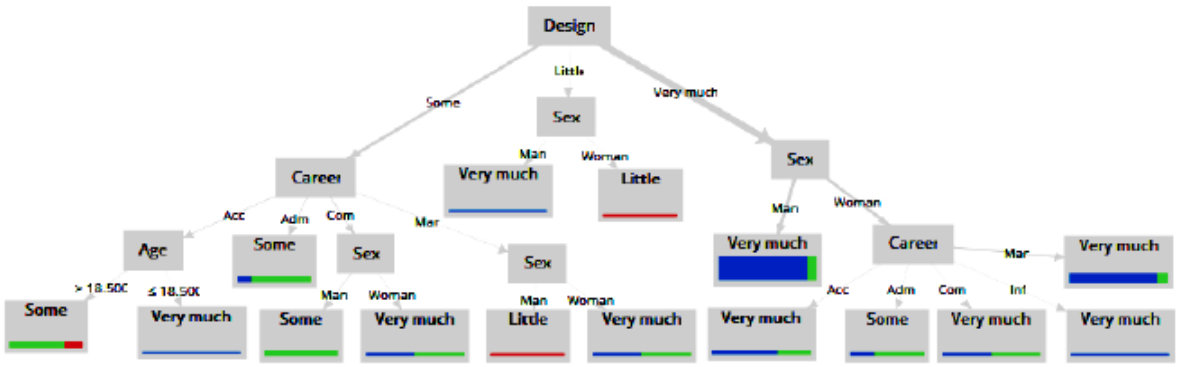

Figure 13. Predictive model 2

The accuracy of the predictive model 2 on the design of WABT and motivation of the student is 83.61% (See Figure 14).

accuracy: 83.61%

	true Very much	true Some	true Little	class precision
pred. Very much	36	7	0	83.72%
pred. Some	2	13	1	81.25%
pred. Little	0	0	2	100.00%
class recall	94.74%	65.00%	66.67%	

Figure 14. Accuracy of the predictive model 2

Figure 15 shows the predictive model 3. If the student considers that the content of WABT facilitates some the teaching-learning process and studies the Bachelor's degree in Marketing (Mar) then this web application favors some the autonomy of the student during the educational process on Bayes' theorem.

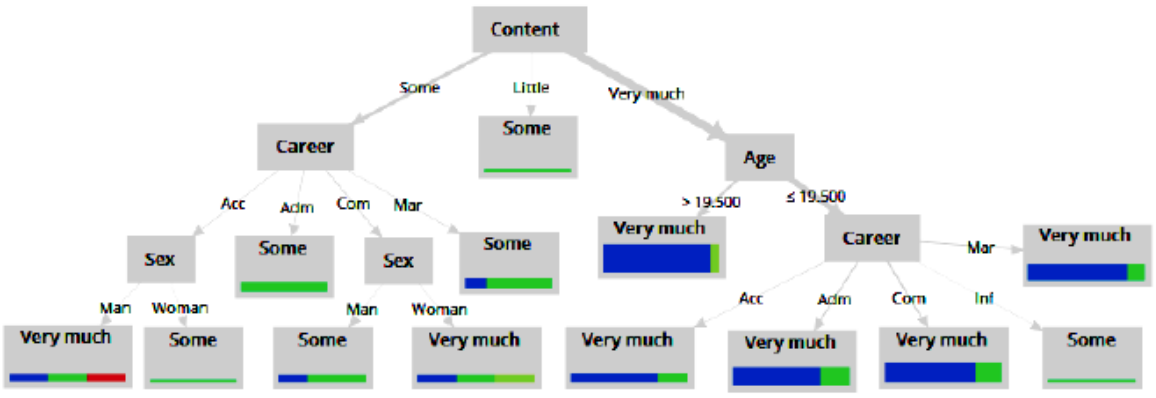

Figure 15. Predictive model 3

The accuracy of the predictive model 3 on the content of WABT and autonomy of the student is 78.69% (See Figure 16).

accuracy: 78.69%

	true Very much	true Some	true Little
pred. Very much	36	8	2
pred. Some	2	12	0
pred. Little	0	0	0
pred. Too little	0	0	0
class recall	94.74%	60.00%	0.00%

Figure 16. Accuracy of the predictive model 3

Figure 17 shows the predictive model 4. If the student considers that the design of WABT facilitates very much the teaching-learning process and is older than 19.5 years then this web application favors very much the autonomy of the student during the educational process on Bayes' theorem.

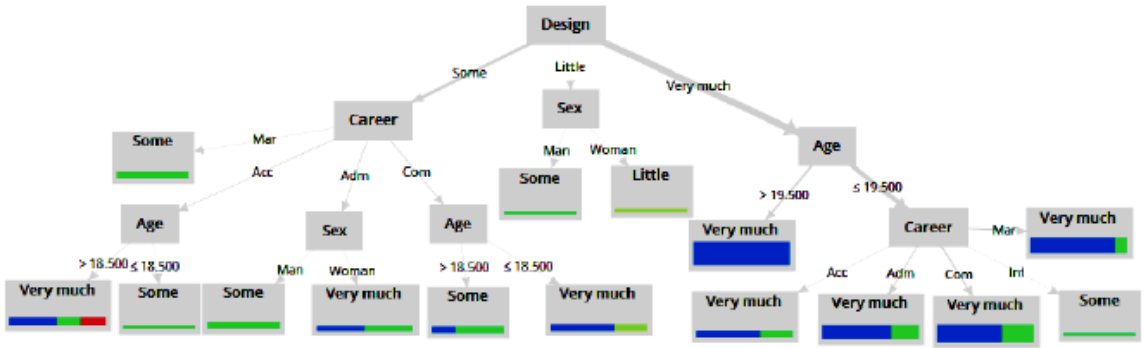

Figure 17. Predictive model 4

Also, if the student considers that the design of WABT facilitates some the teaching-learning process, studies the Bachelor's degree in Administration (Adm) and is woman then this web application favors very much the autonomy of the student during the educational process on Bayes' theorem (See Figure 17). The accuracy of the predictive model on the design of WABT and autonomy of the student is 80.33% (See Figure 18).

accuracy: 80.33%

	true Very much	true Some	true Little
pred. Very much	37	9	1
pred. Some	1	11	0
pred. Little	0	0	1
pred. Too little	0	0	0
class recall	97.37%	55.00%	50.00%

Figure 18. Accuracy of the predictive model 4

Perceived Usefulness

The results of machine learning with 60% of training indicate that hypothesis 5 (0.440), hypothesis 6 (0.727), hypothesis 7 (0.403) and hypothesis 8 (0.880) are accepted (See Table 7).

Table 7. Machine learning about knowledge and Skills of WABT (60% of training)

Hypothesis	Linear regression	Conclusion	Squared_error
H5:Assimilation of knowledge through WABT → Motivation	y = 0.440x + 0.818	Accepted: 0.440	0.172
H6: Development of skills through WABT → Motivation	y = 0.727x + 0.454	Accepted: 0.727	0.253
H7: Assimilation of knowledge through WABT → Autonomy	y = 0.403x + 0.892	Accepted: 0.403	0.213
H8: Development of skills through WABT → Autonomy	y = 0.880x + 0.287	Accepted: 0.880	0.282

Hypothesis 5, 6, 7 and 8 of Assimilation of knowledge and development of skills through WABT are accepted through machine learning with 70% of training (See Table 8).

Table 8. Machine learning about knowledge and Skills of WABT (70% of training)

Hypothesis	Linear regression	Conclusion	Squared_error
H5:Assimilation of knowledge through WABT → Motivation	y = 0.535x + 0.697	Accepted: 0.535	0.201
H6: Development of skills through WABT → Motivation	y = 0.731x + 0.459	Accepted: 0.731	0.300
H7: Assimilation of knowledge through WABT → Autonomy	y = 0.425x + 0.841	Accepted: 0.425	0.231
H8: Development of skills through WABT → Autonomy	y = 0.889x + 0.257	Accepted: 0.889	0.371

The results of machine learning with 80% of training indicate that hypothesis 5 (0.537), hypothesis 6 (0.706), hypothesis 7 (0.414) and hypothesis 8 (0.824) are accepted (See Table 9).

Table 9. Machine learning about knowledge and Skills of WABT (80% of training)

Hypothesis	Linear regression	Conclusion	Squared_error
H5:Assimilation of knowledge through WABT → Motivation	y = 0.537x + 0.674	Accepted: 0.537	0.230
H6: Development of skills through WABT → Motivation	y = 0.706x + 0.464	Accepted: 0.706	0.340
H7: Assimilation of knowledge through WABT → Autonomy	y = 0.414x + 0.857	Accepted: 0.414	0.236
H8: Development of skills through WABT → Autonomy	y =0.824x + 0.331	Accepted: 0.824	0.326

Figure 19 shows the predictive model 5. If the student considers that the assimilation of knowledge through WABT facilitates some the teaching-learning process, studies the Bachelor's degree in Commerce (Com) and is older than 19.5 years then this web application favors very much the motivation of the student during the educational process on Bayes' theorem.

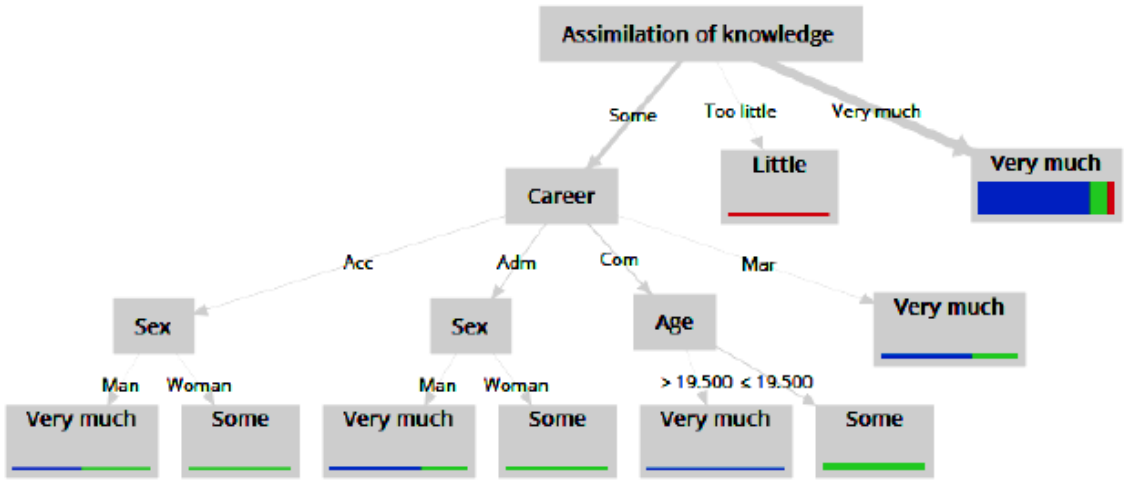

Figure 19. Predictive model 5

The accuracy of the predictive model on the assimilation of knowledge through WABT and motivation of the student is 83.61% (See Figure 20).

accuracy: 83.61%

	true Very much	true Some	true Little	class precision
pred. Very much	38	8	2	79.17%
pred. Some	0	12	0	100.00%
pred. Little	0	0	1	100.00%
class recall	100.00%	60.00%	33.33%	

Figure 20. Accuracy of the predictive model 5

Figure 21 shows the predictive model 6. If the student considers the development of skills through WABT that facilitates some the teaching-learning process and studies the Bachelor's degree in Administration (Adm) then this web application favors some the motivation of the student during the educational process on Bayes' theorem.

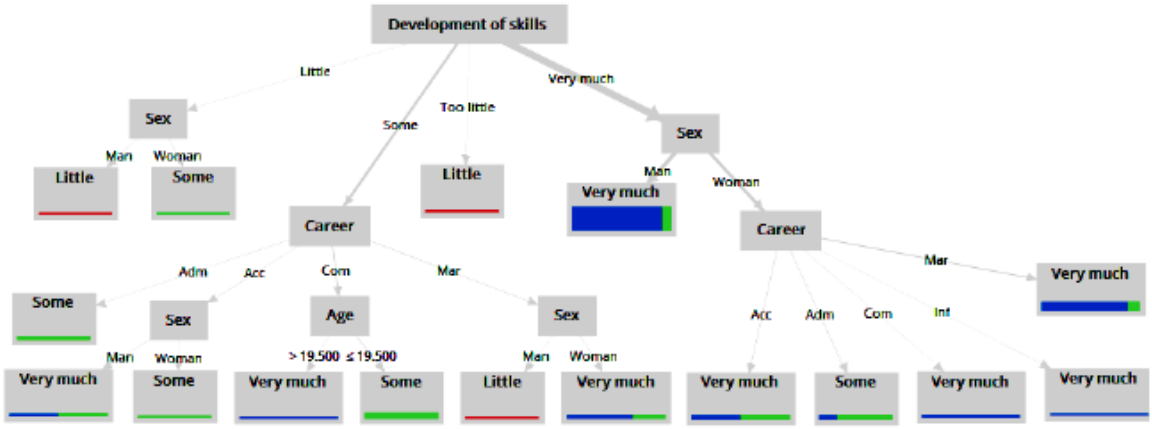

Figure 21. Predictive model 6

The accuracy of the predictive model on the development of skills through WABT and motivation of the student is 86.89% (See Figure 22).

accuracy: 86.89%

	true Very much	true Some	true Little	class precision
pred. Very much	37	7	0	84.09%
pred. Some	1	13	0	92.86%
pred. Little	0	0	3	100.00%
class recall	97.37%	65.00%	100.00%	

Figure 22. Accuracy of the predictive model 6

Figure 23 shows the predictive model 7. If the student considers that the assimilation of knowledge through WABT facilitates some the teaching-learning process and studies the Bachelor's degree in Administration (Adm) then this web application favors some the autonomy of the student during the educational process on Bayes' theorem.

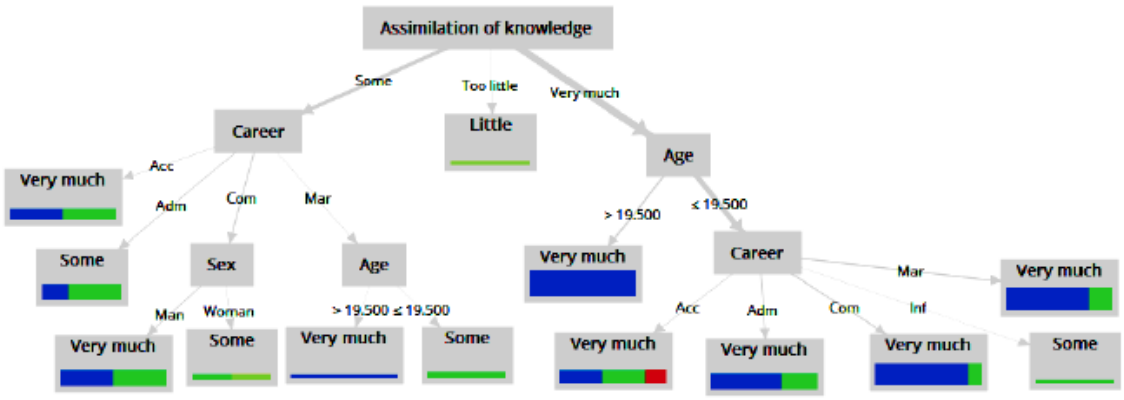

Figure 23. Predictive model 7

The accuracy of the predictive model on the assimilation of knowledge through WABT and autonomy of the student is 73.77% (See Figure 24).

accuracy: 73.77%

	true Very much	true Some	true Little	true Too little	class precision
pred. Very much	36	12	0	1	73.47%
pred. Some	2	8	1	0	72.73%
pred. Little	0	0	1	0	100.00%
pred. Too little	0	0	0	0	0.00%
class recall	94.74%	40.00%	50.00%	0.00%	

Figure 24. Accuracy of the predictive model 7

Figure 25 shows the predictive model 8. If the student considers that the development of skills through WABT facilitates some the teaching-learning process, is older than 19.5 years and studies the Bachelor's degree in Marketing (Mar) then this web application favors very much the autonomy of the student during the educational process on Bayes' theorem.

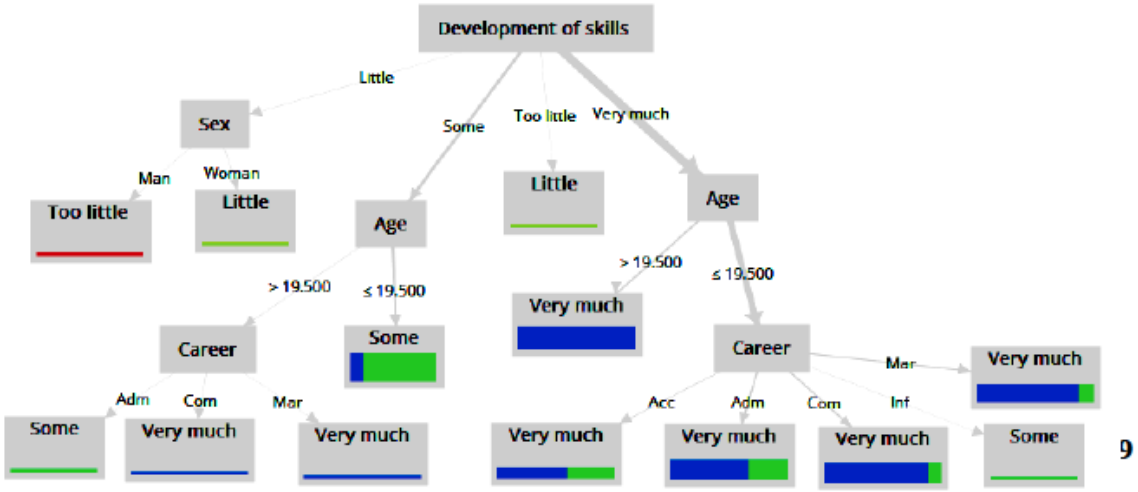

Figure 25. Predictive model 8

The accuracy of the predictive model on the development of skills through WABT and autonomy of the student is 85.25% (See Figure 26).

accuracy: 85.25%

	true Very much	true Some	true Little	true Too little	class precision
pred. Very much	36	7	0	0	83.72%
pred. Some	2	13	0	0	86.67%
pred. Little	0	0	2	0	100.00%
pred. Too little	0	0	0	1	100.00%
class recall	94.74%	65.00%	100.00%	100.00%	

Figure 26. Accuracy of the predictive model 8

Intention

The results of machine learning with 60% of training indicate that hypothesis 9 (0.351), hypothesis 10 (0.421), hypothesis 11 (0.282) and hypothesis 12 (0.351) are accepted (See Table 10).

Table 10. Machine learning about Motivation and Autonomy (60% of training)

Hypothesis	Linear regression	Conclusion	Squared_error
H9: Motivation → personalized learning through WABT	y = 0.351x + 0.840	Accepted: 0.351	0.173
H10: Autonomy → personalized learning through WABT	y = 0.421x + 0.731	Accepted: 0.421	0.136
H11 Motivation → active role through WABT	y = 0.282x + 0.853	Accepted: 0.282	0.382
H12: Autonomy → active role through WABT	y = 0.351x + 0.803	Accepted: 0.351	0.340

Hypothesis 9, 10, 11 and 12 of Motivation and Autonomy are accepted through machine learning with 70% of training (See Table 11).

Table 11. Machine learning about Motivation and Autonomy (70% of training)

Hypothesis	Linear regression	Conclusion	Squared_error
H9: Motivation → personalized learning through WABT	y = 0.340x + 0.827	Accepted: 0.340	0.187
H10: Autonomy → personalized learning through WABT	y = 0.430x + 0.702	Accepted: 0.430	0.149
H11 Motivation → active role through WABT	y = 0.325x + 0.801	Accepted: 0.325	0.438
H12: Autonomy → active role through WABT	y = 0.384x + 0.757	Accepted: 0.384	0.398

The results of machine learning with 80% of training indicate that hypothesis 9 (0.395), hypothesis 10 (0.447), hypothesis 11 (0.381) and hypothesis 12 (0.434) are accepted (See Table 12).

Table 12. Machine learning about Motivation and Autonomy (80% of training)

Hypothesis	Linear regression	Conclusion	Squared_error
H9: Motivation → personalized learning through WABT	y = 0.395x + 0.757	Accepted: 0.395	0.229
H10: Autonomy → personalized learning through WABT	y = 0.447x + 0.675	Accepted: 0.447	0.159
H11 Motivation → active role through WABT	y = 0.381x + 0.736	Accepted: 0.381	0.574
H12: Autonomy → active role through WABT	y = 0.434x + 0.694	Accepted: 0.434	0.534

Figure 27 shows the predictive model 9. If the student considers that the motivation of the student favors very much the teaching-learning process on Bayes' theorem and studies the Bachelor's degree in Accountancy (Acc) then this web application facilitates very much the personalized learning through WABT.

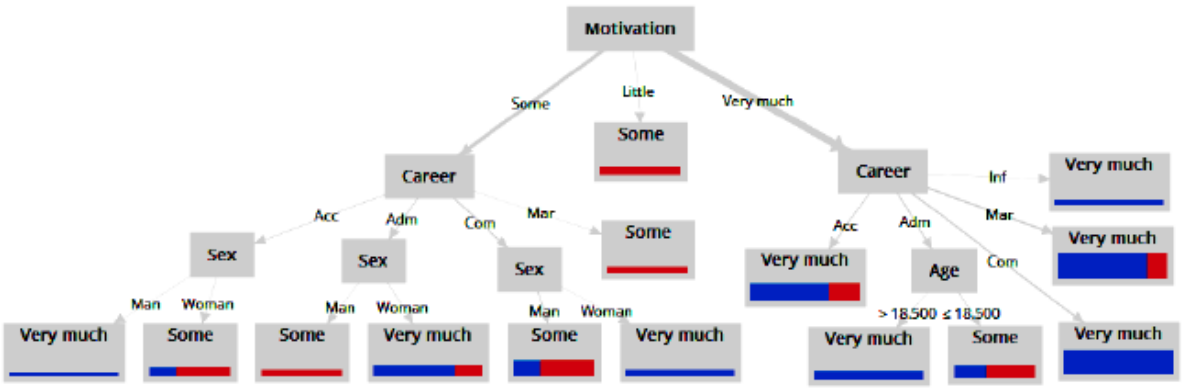

Figure 27. Predictive model 9

If the student considers that the motivation of the student favors very much the teaching-learning process on Bayes' theorem and studies the Bachelor's degree in Marketing (Mar) then this web application facilitates very much the personalized learning through WABT (See Figure 27). The accuracy of the predictive model on the motivation of the student and personalized learning through WABT is 83.61% (See Figure 28).

accuracy: 83.61%

	true Very much	true Some	class precision
pred. Very much	35	5	87.50%
pred. Some	5	16	76.19%
class recall	87.50%	76.19%	

Figure 28. Accuracy of the predictive model 9

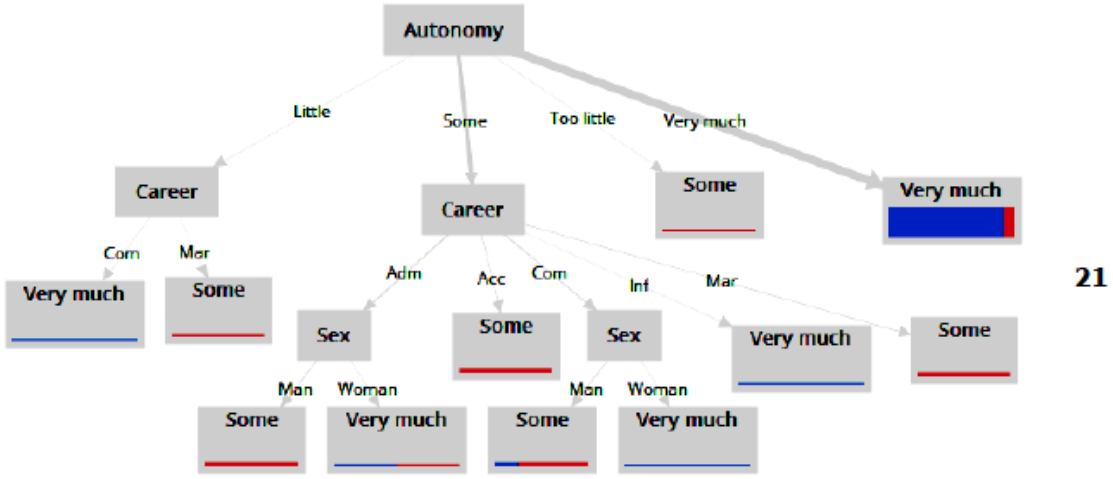

Figure 29. Predictive model 10

The accuracy of the predictive model on the autonomy of the student and personalized learning through WABT is 91.80% (See Figure 30).

accuracy: 91.80%

	true Very much	true Some	class precision
pred. Very much	39	4	90.70%
pred. Some	1	17	94.44%
class recall	97.50%	80.95%	

Figure 30. Accuracy of the predictive model 10

Figure 31 shows the predictive model 11. If the student considers that the motivation of the student favors some the teaching-learning process on Bayes' theorem and studies the Bachelor's degree in Administration (Adm) and is man then this web application facilitates some the active role through WABT.

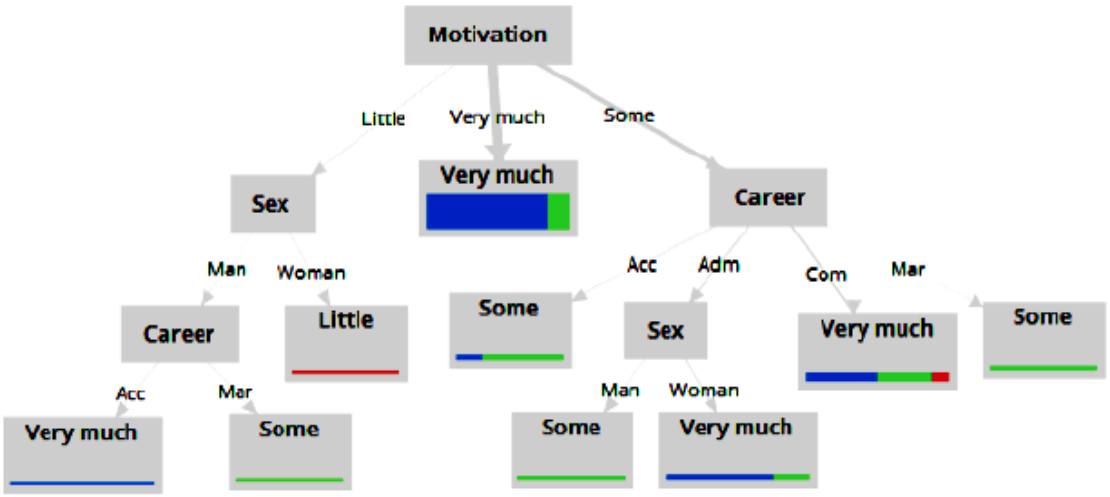

Figure 31. Predictive model 11

The accuracy of the predictive model on the motivation of the student and the active role through WABT is 80.33% (See Figure 32).

accuracy: 80.33%

	true Very much	true Some	true Little	class precision
pred. Very much	40	10	1	78.43%
pred. Some	1	8	0	88.89%
pred. Little	0	0	1	100.00%
class recall	97.56%	44.44%	50.00%	

Figure 32. Accuracy of the predictive model 11

Figure 33 shows the predictive model 12. If the student considers that the autonomy of the student favors some the teaching-learning process on Bayes' theorem, studies the Bachelor's degree in Commerce (Com) and is man then this web application facilitates very much the active role through WABT.

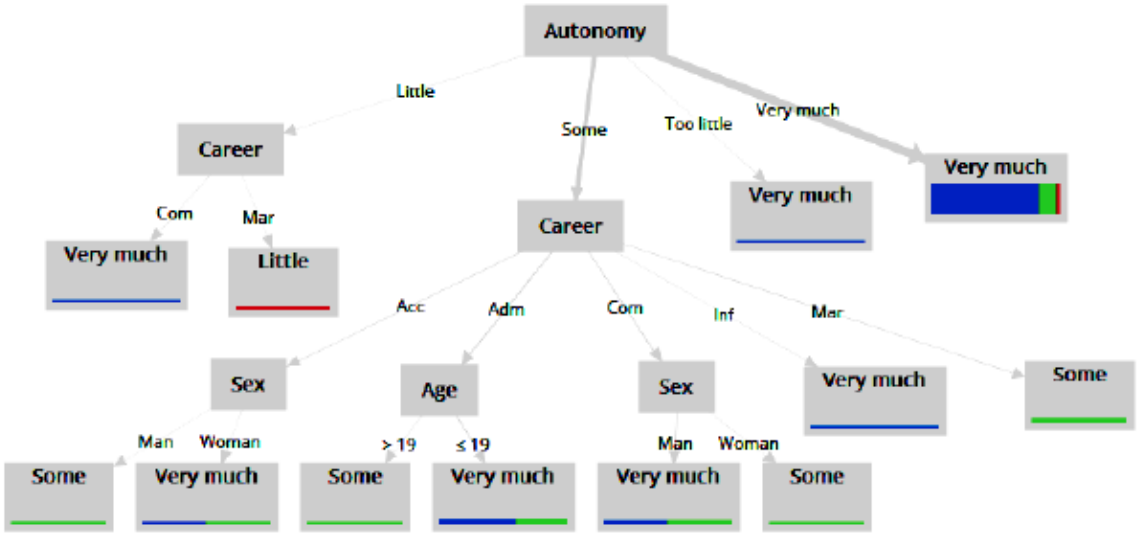

Figure 33. Predictive model 12

The accuracy of the predictive model on the autonomy of the student and the active role through WABT is 81.97% (See Figure 34).

accuracy: 81.97%

	true Very much	true Some	true Little	class precision
pred. Very much	41	10	1	78.85%
pred. Some	0	8	0	100.00%
pred. Little	0	0	1	100.00%
class recall	100.00%	44.44%	50.00%	

Figure 34. Accuracy of the predictive model 12

Perception of the Students

According to the students of the Statistical instrumentation for Business subject, WABT facilitates the teaching-learning process on Bayes' theorem:

Yes, it helps to practice the probability of Bayes' theorem (Student 10, Female, 20 years old, Marketing).

Yes, it helps to understand the topics (Student 50, Female, 18 years old, Marketing).

WABT is an innovative web tool for the field of statistics:

Yes, it is not like the traditional methods (Student 26, Female, 19 years old, Accounting).

Yes, because it shows the results in detail (Student 61, Female, 20 years old, Administration).

According to the participants, the web interface of WABT is friendly and attractive:

Yes, it is attractive (Student 1, Female, 18 years old, Marketing).

Yes, it is very friendly (Student 23, Male, 19 years old, Commerce).

Likewise, the simulation of WABT facilitates the presentation of the procedure to calculate Bayes' theorem:

Yes, because we can analyze several cases (Student 6, Male, 19 years old, Accounting).

Yes, because it shows the procedure and results (Student 40, Male, 18 years old, Accounting).

One of the benefits of WABT is related to ease of use and fast:

Easy to use and friendly (Student 3, Male, 20 years old, Accounting).

Easy, simple, fast and dynamic (Student 20, Female, 19 years old, Marketing).

Another benefit on WABT is linked to the learning process:

Innovation and personalization of learning (Student 50, Female, 18 years old, Marketing).

Help to review (Student 51, Male, 18 years old, Administration).

The students of the Statistical Instrumentation for Businesses subject are satisfied to use technology during the educational process on the Bayes' theorem:

Yes, I liked using it (Student 11, Female, 18 years old, Commerce).

Yes, because I improved my knowledge (Student 48, Female, 18 years old, Accounting).

Finally, the students point out that WABT is a useful application for the teaching-learning process:

Yes, it helps a lot (Student 23, Male, 19 years old, Commerce).

Yes, it is very helpful (Student 30, Male, 18 years old, Administration).

DISCUSSION

In the 21st century, teachers are transforming school activities through technological tools (Morales, Escandell, & Castro, 2018; Salas, Salas, & Salas, 2019). In particular, this mixed research analyzes the impact of WABT during the educational process on Bayes' theorem. This study shares the ideas of various authors (e.g., Morales, Escandell, & Castro, 2018; Tikoria & Agariya, 2017) on the role of digital tools as strategic resources to achieve the objectives of educational institutions. For example, WABT uses simulation to present the probabilities of events, intersection and conditional about the supply of products.

The educational context has changed due to the use of applications in school activities (Tikoria & Agariya, 2017). In particular, the students of the Bachelor of Administration, Commerce, Accounting, Information Technology and Marketing mention that WABT is an innovative and useful web tool for the field of statistics. The results of machine learning (60%, 70% and 80% of training) indicate that all the hypotheses about the impact of WABT in the educational process are accepted. For example, the content and design of WABT positively influences the motivation and autonomy of the student. In the same way, the assimilation of knowledge and development of skills through WABT positively influences the motivation and autonomy of the student. On the other hand, the motivation and autonomy of the student positively influences the personalized learning and active role during the use of WABT.

Universities are promoting the use of applications in the classroom to develop competences in students (Hajhashemi, Caltabiano, & Anderson, 2016). Therefore, teachers must use the models on the acceptance of technology in order to analyze the impact of digital tools in the teaching-learning process. TAM model is a reference framework designed to analyze and evaluate the degree of acceptance about the use of technology in organizations (Chen & Chengalur, 2015; Doleck, Bazelais, & Lemay, 2017; Liu, Chen, Sun, Wible, & Kuo, 2010). In this research, this model indicates that WABT favors the personalized learning and active role of students in the Statistical Instrumentation for Business subject. In addition, Perceived Ease of Use and Perceived Usefulness of this web application positively influence the motivation and autonomy during the educational process on Bayes' theorem.

According to Guspatni (2018), the font, images and color allow the construction of pleasant and useful web spaces for the educational field. In particular, WABT presents a pleasant, simple, useful, easy and fast interface for the teaching-learning process. Data science (decision tree technique) allows the identification of predictive models on the use of WABT in the educational process about Bayes' theorem. The accuracy of these predictive models is between 73.77% and 91.80%.

Finally, ICTs play a fundamental role during the organization and implementation of school activities (Negre, Marin, & Perez, 2018). In fact, technological tools facilitate student-centered learning (Bortnik, Stozhko, Pervukhina, Tchernysheva, & Belysheva, 2017).

CONCLUSION

Technology is transforming the conditions for teaching and learning. In particular, WABT facilitates the educational process on Bayes' theorem by simulating the probabilities of events, intersection and conditional about the supply of products. TAM model allows identifying the impact of WABT in the educational field, that is, this web application favors the personalized learning and active role of students in the Statistical Instrumentation for Business subject. Also, Perceived Ease of Use (content and design of WABT) and Perceived Usefulness (assimilation of knowledge and development of skills through WABT) positively influence the motivation and autonomy of students.

The limitations of this research are related to the simulation of Bayes' theorem through the presentation of an exercise about the supply of products. In addition, the content of WABT is designed only in the Spanish language. Therefore, future research can build web applications to show various simulations of probability. Artificial intelligence can be used in data simulation to customize the contents of applications. Also, the construction of the content must consider the use of different languages.

Rapidminer tool is an ideal application to perform calculations on machine learning with 60%, 70% and 80% of training(linear regression) and build predictive models by means of data science (decision tree technique). Technology is fostering the creation of new scenarios for learning and teaching such as WABT. Therefore, teachers must identify, select, analyze and evaluate the impact of digital tools in order to develop competences in students.

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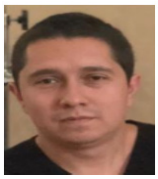

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