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Abstract—This quantitative research aims to analyze the impact of the Web Application for the Teaching-Learning process on Simple Discount (WATLSD) through data science and machine learning (linear regression). The sample is composed of 42 students of the careers in Administration and Marketing who attended the Financial Mathematics course during the 2018 school year. The ADDIE model allows organizing the construction of the WATLSD through the stages of Analysis, Design, Development, Implementation and Evaluation. The results of machine learning indicate that the use of the WATLSD during the learning process positively influences the motivation, active role and development of mathematical skills. Likewise, data science establishes 3 predictive models on the use of the WATLSD in the educational field. Finally, advances in technology such as the WATLSD allow the creation of new virtual spaces for learning and teaching.

Keywords—Educational technology, Teaching, Learning, ICT, Data science, Machine learning

1 Introduction

Today, technology is changing the way of assimilating knowledge and developing the skills of students [1], [2]. In the 21st century, Internet is modifying the organization of school activities and educational practices [3], [4]. For example, web applications facilitate the personalization of learning through the consultation of information at any time and place [5].

The educational environment is changing because teachers are incorporating digital tools, web platforms and applications in school activities [6], [7]. Even educational institutions seek to create new virtual spaces to increase the motivation of students during the teaching-learning process [8], [9].

According to [10], Information and Communication Technologies (ICT) are essential to organize the school activities in the 21st century. In fact, technology is transforming the way of managing the information and content of the courses [10], [11].
Teachers have the possibility of building new spaces for learning and teaching through technology [12], [13]. In fact, technological skills of students facilitate the incorporation of ICT into and out of the classroom [14], [15].

This quantitative research analyzes the use of the WATLSD in the teaching-learning process on financial mathematics (Simple Discount) through data science and machine learning.

The research questions are:

- What is the impact of the WATLSD in the teaching-learning process on the Simple Discount (development of mathematical skills, active role and motivation of the students)?
- What are the predictive models of the use of the WATLSD in the teaching-learning process?

2 ICT in the Educational Field

Technological advances such as web platforms and applications positively influence the teaching-learning process about music [16], mathematics [17], reading comprehension [18], engineering [19] and English language [20].

One of the challenges of teachers in the 21st century is to develop the skills of students [21]. Various authors (e.g., [10], [16]) mention that the use of technology in school activities allows the development of skills.

For example, Moodle facilitates the creation of new virtual spaces that allow developing skills on music issues [16]. Similarly, web applications allow the development of grammatical skills in the course on Language Teaching [10]. Even the incorporation of web applications in the field of statistics favors the development of mathematical skills and active role of the students [5].

2.1 Construction of educational web applications

Various authors (e.g., [5], [18], [20], [22]) have built web applications in order to improve the teaching-learning process and develop the skills of students. For example, [20] designed and built a web application to facilitate the understanding of the alphabet and pronunciation of letters in the English language.

The benefits related to the incorporation of web applications in school activities are the consultation of the contents from any place and time [5]. Also, the use of web applications allows the customization of the educational process because students control the pace of learning ([10], [18], [22]). Even students have the advantage of using various technological tools such as educational platforms and web applications from smartphones, tablets and laptops ([20], [23], [24]).

For example, [22] created a web application to facilitate the assimilation of knowledge about reading and writing at the basic educational level. Similarly, [17] built the MaGrid application with the purpose of facilitating the teaching-learning process and developing mathematical skills at the basic educational level.
[18] developed the Quráni application to facilitate reading comprehension considering the user profile with hearing problems. Even [5] built a web application to facilitate the development of mathematical skills in the field of statistics.

Web applications allow transforming the educational context because students have access to information at any time and place ([22], [18]). In fact, mobile devices facilitate the use of web applications during the teaching-learning process ([25], [26]).

3 Methodology

The objective of this quantitative research aims to analyze the impact of the WATLSD in the teaching-learning process on financial mathematics (Simple Discount) through data science and machine learning.

3.1 Participants

The sample is composed of 42 students (20 men and 22 women) of Administration (n=16, 38.10%) and Marketing (n=26, 61.90%) who studied Financial Mathematics course at a university in Mexico City during the 2018 school year.

The machine learning allows finding the linear regressions with 60% (n = 25 students), 70% (n = 29 students) and 80% (n = 33 students) of training section to evaluate the research hypotheses.

In addition, 40% (n = 17 students), 30% (n = 13 students) and 20% (n = 9 students) of the evaluation section allows identifying the accuracy of linear regressions on the impact of the WATLSD in the teaching-learning process.

3.2 Procedure

The procedure of this quantitative research began with the use of the ADDIE model to analyze the characteristics and needs of the students (See Table 1).

Table 1. Use of the ADDIE model

<table>
<thead>
<tr>
<th>No.</th>
<th>Stage</th>
<th>Aspect</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Analysis</td>
<td>Course</td>
<td>Financial Mathematics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unit</td>
<td>The Interest unit contains the topic on Simple Discount</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Objective</td>
<td>The student will understand the calculation of the Simple Discount</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students</td>
<td>The students attended the third semester of careers in Administration and Marketing during the 2018 school year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Problem</td>
<td>The students of Administration and Marketing have difficulty to assimilate the knowledge on the Simple Discount</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ICT</td>
<td>Design and construction of the WATLSD to facilitate the learning process through simulation of data</td>
</tr>
<tr>
<td>2</td>
<td>Design</td>
<td>General objective</td>
<td>The student will understand and use the formulas on the Simple Discount in the practical context</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Particular objectives</td>
<td>The student will understand the concepts of Nominal principal, Accumulated amount and Simple Discount</td>
</tr>
</tbody>
</table>
The student will use the formulas on the Accumulated amount, Simple Discount and Effective principal.

The student will relate the theoretical concepts on Simple Discount to the practical context.

The WATLSD presents the contents on the use of the Simple Discount during the request for a bank loan.

### Development

**Technology Incorporation**

- The WATLSD requests information about a bank credit to start the simulation of data.
- The WATLSD presents the procedure to calculate the Accumulated amount of a bank credit.
- The WATLSD presents the procedure to calculate the Simple Discount of a bank credit.
- The WATLSD presents the procedure to calculate the Effective principal of a bank credit.

### Implementation

**Technology implementation**

- The students of the Financial Mathematics course used this web application during the 2018 school year.

### Evaluation

**Measurement instrument**

- The questionnaire consists of 7 closed questions (See Table 2).

The WATLSD was built through HTML and the PHP programming language. The students of the Financial Mathematics course used this web application through the following address: http://sistemasusables.com/mf/descuento/inicio.html

The WATLSD requests information about a bank credit to start the simulation of data (See Fig. 1).

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**Financial Mathematics Discount**

Continue

Fig. 1. Request for information in the WATLSD

The WATLSD presents the calculation of the Accumulated amount (See Fig. 2).
Fig. 2. Calculation of the Accumulated amount in the WATLSD

Fig. 3 shows the calculation of the Simple Discount in the WATLSD.

Fig. 3. Calculation of the Simple Discount in the WATLSD

The WATLSD presents the calculation of the Effective principal (See Fig. 4).
Fig. 4. Calculation of the Effective principal in the WATLSD

Fig. 5 shows the model of technological acceptance on the use of the WATLSD during the teaching-learning process.

The research hypotheses are:

- Hypothesis 1 (H1): The use of the WATLSD during the learning process positively influences the active role of the student
- Hypothesis 2 (H2): The use of the WATLSD during the learning process positively influences the motivation of the student
- Hypothesis 3 (H3): The use of the WATLSD during the learning process positively influences the development of mathematical skills

On the other hand, data science allows the identification of the following predictive models on the use of the WATLSD in the educational process:

- Predictive model 1 on the WATLSD and active role of the student
- Predictive model 2 on the WATLSD and motivation of the student
- Predictive model 3 on the WATLSD and development of mathematical skills
3.3 Data analysis

The Rapidminer tool allows performing the calculation of the machine learning (linear regression) to evaluate the research hypotheses and build the predictive models on the use of the WATLSD during the educational process of Simple Discount.

Machine learning divides the sample into two groups, that is, the training section (60%, 70% and 80%) allows obtaining the linear regression and the evaluation section (40%, 30% and 20%) allows knowing the accuracy of linear regression (See Fig. 6).

Fig. 6. Calculation of machine learning in the Rapidminer tool

The decision tree technique allows building the predictive models through the Rapidminer tool (See Fig. 7).

Finally, the SPSS software allows validating the measurement instrument by means of the Load Factor, Cronbach’s Alpha, Average Variance Extracted (AVE) and Composite Reliability (CR).

3.4 Data collection

The measurement instrument (questionnaire) has 7 closed questions related to the use of the WATLSD in the Financial Mathematics course during the 2018 school year (See Table 2).
Table 2. Questionnaire

<table>
<thead>
<tr>
<th>No.</th>
<th>Variable</th>
<th>Dimension</th>
<th>Question</th>
<th>Answer</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Profile of the student</td>
<td>Sex</td>
<td>1. Indicate your sex</td>
<td>Man</td>
<td>20</td>
<td>47.62%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Woman</td>
<td>22</td>
<td>52.38%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Career</td>
<td>2. Indicate your career</td>
<td>Administration</td>
<td>16</td>
<td>38.10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Marketing</td>
<td>26</td>
<td>61.90%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Age</td>
<td>3. Indicate your age</td>
<td>19 years</td>
<td>30</td>
<td>71.43%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20 years</td>
<td>7</td>
<td>16.67%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21 years</td>
<td>4</td>
<td>9.52%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22 years</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>23 years</td>
<td>1</td>
<td>2.38%</td>
</tr>
<tr>
<td>2</td>
<td>WATLSD</td>
<td>Learning process</td>
<td>4. The WATLSD improves the learning process on financial mathematics</td>
<td>Too much (1)</td>
<td>25</td>
<td>59.52%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Much (2)</td>
<td>17</td>
<td>40.48%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Little (3)</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Too little (4)</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Active role</td>
<td>5. The WATLSD improves the active role of the student</td>
<td>Too much (1)</td>
<td>36</td>
<td>85.71%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Much (2)</td>
<td>6</td>
<td>14.29%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Little (3)</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Too little (4)</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motivation</td>
<td>6. The WATLSD improves the motivation of the student</td>
<td>Too much (1)</td>
<td>26</td>
<td>61.90%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Much (2)</td>
<td>15</td>
<td>35.71%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Little (3)</td>
<td>1</td>
<td>2.38%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Too little (4)</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Development of mathematical skills</td>
<td>7. The WATLSD improves the development of mathematical skills</td>
<td>Too much (1)</td>
<td>24</td>
<td>57.14%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Much (2)</td>
<td>17</td>
<td>40.48%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Little (3)</td>
<td>1</td>
<td>2.38%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Too little (4)</td>
<td>0</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

The Load Factor (> 0.50), Cronbach's Alpha (> 0.70) and Composite Reliability (> 0.70) values guarantee the reliability of the questionnaire [27]. Table 3 shows that the values on the Load Factor exceed 0.650, that is, Learning Process (0.860), Active Role (0.735), Motivation (0.757) and Development of Mathematical Skills (0.654). Also, the values of Cronbach's Alpha (0.731) and Composite Reliability (0.840) are greater than 0.70.
Table 3. Validation of the questionnaire

<table>
<thead>
<tr>
<th>No.</th>
<th>Variable</th>
<th>Dimension</th>
<th>Load Factor</th>
<th>Cronbach’s Alpha</th>
<th>Average Variance Extracted</th>
<th>Composite Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>WATLSD</td>
<td>Learning process</td>
<td>0.860</td>
<td>0.731</td>
<td>0.570</td>
<td>0.840</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Active role</td>
<td>0.735</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motivation</td>
<td>0.757</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Development of Mathematical Skills</td>
<td>0.654</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4 Results

The WATLSD improves too much (n=25, 59.52%) and much (n=17, 40.48%) the learning process about financial mathematics. Likewise, the results of machine learning with 60%, 70% and 80% of training indicate that the use of the WATLSD during the learning process positively influences the active role, motivation and development of mathematical skills (See Table 4).

Table 4. Results of machine learning

<table>
<thead>
<tr>
<th>No.</th>
<th>Hypothesis</th>
<th>Training</th>
<th>Linear regression</th>
<th>Conclusion</th>
<th>Square error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H1: WATLSD → active role of the student</td>
<td>60%</td>
<td>( y = 0.428x + 0.571 )</td>
<td>Accepted: 0.428</td>
<td>0.365</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70%</td>
<td>( y = 0.444x + 0.555 )</td>
<td>Accepted: 0.444</td>
<td>0.372</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80%</td>
<td>( y = 0.363x + 0.636 )</td>
<td>Accepted: 0.363</td>
<td>0.409</td>
</tr>
<tr>
<td>2</td>
<td>H2: WATLSD → motivation of the student</td>
<td>60%</td>
<td>( y = 0.833x + 0.333 )</td>
<td>Accepted: 0.833</td>
<td>0.433</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70%</td>
<td>( y = 0.849x + 0.300 )</td>
<td>Accepted: 0.849</td>
<td>0.489</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80%</td>
<td>( y = 0.778x + 0.351 )</td>
<td>Accepted: 0.778</td>
<td>0.464</td>
</tr>
<tr>
<td>3</td>
<td>H3: WATLSD → development of mathematical skills</td>
<td>60%</td>
<td>( y = 0.436x + 0.841 )</td>
<td>Accepted: 0.436</td>
<td>0.456</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70%</td>
<td>( y = 0.527x + 0.722 )</td>
<td>Accepted: 0.527</td>
<td>0.509</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80%</td>
<td>( y = 0.422x + 0.881 )</td>
<td>Accepted: 0.422</td>
<td>0.439</td>
</tr>
</tbody>
</table>

4.1 Active role of the student

The WATLSD improves too much (n=36, 85.71%) and much (n=6, 14.29%) the active role of the student (See Table 2). Likewise, the results of machine learning with 60% (0.428), 70% (0.444) and 80% (0.363) indicate that hypothesis 1 is accepted (See Table 4). Therefore, the use of the WATLSD during the learning process positively influences the active role of the student.

Fig. 8 shows the predictive model 1 on the use of the WATLSD in the educational context. For example, if the student thinks that the WATLSD improves much the learning process on financial mathematics, has an age ≤ 19.5 years and is a man then the WATLSD improves much the active role of the student.
Predictive model 1 on the use of the WATLSD in the educational context has 4 conditions and has an accuracy of 90.48%. For example, if the student thinks that the WATLSD improves much the learning process on financial mathematics, has an age ≤ 19.5 years and is a woman then the WATLSD improves too much the active role of the student.

4.2 Motivation of the student

The WATLSD improves too much (n=26, 61.90%), much (n=15, 35.71%) and little (n=1, 2.38%) the motivation of the student (See Table 2). Likewise, the results of machine learning with 60% (0.833), 70% (0.849) and 80% (0.778) indicate that hypothesis 2 is accepted (See Table 4). Therefore, the use of the WATLSD during the learning process positively influences the motivation of the student.

Fig. 9 shows the predictive model 2 on the use of the WATLSD in the educational context. For example, if the student thinks that the WATLSD improves much the learning process on financial mathematics and has an age > 19.5 years then the WATLSD improves much the motivation of the student.
Predictive model 2 on the use of the WATLSD in the educational context has 4 conditions and has an accuracy of 88.10%. For example, if the student thinks that the WATLSD improves too much the learning process on financial mathematics and takes the career of Administration then the WATLSD improves too much the motivation of the student.

4.3 Development of mathematical skills

The WATLSD improves too much (n=24, 57.14%), much (n=17, 40.48%) and little (n=1, 2.38%) the development of mathematical skills (See Table 2). Likewise, the results of machine learning with 60% (0.436), 70% (0.527) and 80% (0.422) indicate that hypothesis 3 is accepted (See Table 4). Therefore, the use of the WATLSD during the learning process positively influences the development of mathematical skills.

Fig. 10 shows the predictive model 3 on the use of the WATLSD in the educational context. For example, if the student thinks that the WATLSD improves much the learning process on financial mathematics and has an age ≤ 19.5 years then the WATLSD improves much the development of mathematical skills.
Fig. 10. Predictive model 3 on the use of the WATLSD

Predictive model 3 on the use of the WATLSD in the educational context has 5 conditions and has an accuracy of 78.57%. For example, if the student thinks that the WATLSD improves too much the learning process on financial mathematics and has an age ≤ 22 years then the WATLSD improves too much the development of mathematical skills.

5 Discussion

Today, technology is changing the organization and implementation of school activities [13]. For example, the incorporation of web applications and digital tools in the teaching-learning process facilitates the assimilation of knowledge and development of skills.

5.1 Active role of the student

Most of the students in the Financial Mathematics course think that the WATLSD improves too much (n = 36, 85.71%) the active role of the student. Even the results of hypothesis 1 on machine learning with 60%, 70% and 80 training are greater than 0.360. Therefore, the use of the WATLSD during the learning process positively influences the active role of the student.

Also, data science identifies 4 predictive conditions on the use of the WATLSD and active role of the student, which are distributed in the Too much (n=2) and Much (n=2) categories.

5.2 Motivation of the student

Most of the students in the Financial Mathematics course think that the WATLSD improves too much (n=26, 61.90%) the motivation of the student. Even the results of
hypothesis 2 on machine learning with 60%, 70% and 80 training are higher than 0.770. Therefore, the use of the WATLSD during the learning process positively influences the motivation of the student.

Also, data science identifies 4 predictive conditions on the use of the WATLSD and motivation of the student, which are distributed in the Too much (n=2) and Much (n=2) categories.

5.3 Development of mathematical skills

Most of the students in the Financial Mathematics course think that the WATLSD improves too much (n=24, 57.14%) the development of mathematical skills. Even the results of hypothesis 3 on machine learning with 60%, 70% and 80 training are greater than 0.420. Therefore, the use of the WATLSD during the learning process positively influences the development of mathematical skills.

Data science identifies 5 predictive conditions on the use of the WATLSD and development of mathematical skills, which are distributed in the Too much (n=2) and Much (n=5) categories.

The WATLSD facilitates the teaching-learning process on the Simple Discount in the Financial Mathematics course through the detailed presentation of the mathematical calculations. In fact, the motivation of the student is the factor that has the greatest positive relationship with the use of the WATLSD during the learning process. On the other hand, the active role of the student is the factor that has the least positive relationship with the use of the WATLSD during the learning process.

The predictive models 1 (90.48%), 2 (88.10%) and 3 (78.57%) on the use of the WATLSD during the learning process have an accuracy greater than 78.50%. Finally, this research shares the ideas of various authors (e.g., [1], [12]) on the fundamental role of technology in the educational field. In particular, the WATLSD allows innovating school activities in the Financial Mathematics course.

6 Conclusion

Universities are transforming the teaching-learning process through the construction of new educational virtual spaces. In particular, the WATLSD is a web application that facilitates the educational process on Simple Discount through the simulation of data.

The results of machine learning indicate that the use of the WATLSD during the learning process improves the active role, motivation and development of mathematical skills. Likewise, data science identifies the predictive conditions on the use of the WATLSD in the Financial Mathematics course.

The limitations of this quantitative research are related to the contents of the WATLSD on Simple Discount. Therefore, future research may analyze the impact of technological tools during the teaching-learning process on Simple Interest, Compound Interest, Amortizations and Annuities.
This quantitative research recommends the design and construction of educational web applications in order to improve teaching-learning conditions. For example, the WATLSD allows the students of the Financial Mathematics course to consult the contents at any time and place.

The implications of this study are the benefits of using technological tools in school activities. In particular, the WATLSD presents the mathematical procedure to facilitate the assimilation of knowledge about the Simple Discount. In conclusion, teachers can create new educational experiences through the construction and use of web applications.

7 References


8 Author

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