Learning tax regulations through rules-based chatbots using decision trees: a case study at the time of COVID-19

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***Abstract*— Chatbots have represented a revolution in how companies relate internally to their collaborators and externally to their customers. The impact they have had is directly related to saving time in business processes, an improvement in experience, and economic savings for those who implement them. At the educational level, various experiences of virtual assistants have been appreciated with promising results about how the tools are exploited against the learning results of the students. This paper presents the experience carried out by accounting students to teach rules related to tax control processes through the use of a rules-based chatbot that uses decision trees. The study focused on remote learning for COVID-19 reasons. The results of this experience are promising in this area, due to the complexity of the content and the little innovation in existing teaching subjects in the area. In general, the students presented an improvement in learning compared to other remote learning techniques.**

Keywords— chatbot, decision tree, tax learning, COVID-19.

I. INTRODUCTION

Motivation in the learning process is relevant because it directly influences the perception and predisposition that students have towards teachers' teaching activities [1]. Therefore, the lack of motivation is one of the most critical causes when studying the failure and desertion of educational systems [2]. This is how educational entities have generated various studies and theories about the impact that motivation has on their students and how to manage this motivation to achieve effective learning in their students [3], [4]. One of the techniques that have become a common factor is the use of technology and software to support the teaching process and enhance student motivation [5].

At the level of business processes or industrial development of the countries, it can be seen that the integration of technologies has taken on significant significance both at the level of economic development [6], [7] and humans [8], [9]. Therefore, being an element that is part of the nucleus of the development of nations, its behavior and integration must be observed at all levels of the development of society.

The integration of technologies in the classroom is a constant challenge that teachers and educational communities must face, but it is necessary based on the global demands on the development of competences in students [10]. Based on this, there are numerous innovations, but the most outstanding and have been most attractive to students are those related to the use of digital credentials, virtual assistants, blockchain, among others [11]–[13].

Learning the theory and application of tax regulations is a great challenge for both educational and tax entities [14]. Moreover, this challenge is increased with the implementation of automated processes that use artificial intelligence or big data in tax administration activities. A more specific case in the use of technologies by tax administrations is the one analyzed in [15] where the social and legal effects on the application of artificial intelligence in tax control processes are considered. That is why education, and especially the study of tax regulations, cannot be exempt from the application, integration, and use of information technologies in its process [16]. The problem, as already discussed in [17] is that in tax learning it is complex, and it increases when countries have constant legislative variability and that finally produces an obsolescence effect on the matters that regulate the taxation of countries, having as an effect a lack of motivation and rejection of students before these subjects and as a consequence very high failure and dropout rates [18].

In terms of educational innovation, this paper will discuss the use of chatbots in the educational process. These kinds of tools belong to the boom of education 3.0 [19], and they are a great support in the training process of the students since they are useful for the availability of information and the resolution of specific doubts quickly and directly. They also have the advantage of a 24-hour one without the need to use support channels and thus are not subject to the conventional tutoring of a teacher.

This is possible due to the different advances that have been generated in the use of artificial intelligence, and in this case in the branch of machine learning [20], big data for data collection and analysis [21] and natural language processing [22]. Based

on this, one edge is the use of predictive models for behavioral mapping, leading to the outcome of decision trees. This type of tree based on the conventional data structures used in computer engineering allows a classification, ordering, and structured access that generates advantages over any linear structure, both in terms of performance and costs of processing cycle by the hardware [23], [24].

In this article, the experience of design and application of a decision tree built based on the subject of tax inspection theory that tax administrations carry out to taxpayers is presented, in a chatbot intended for use by students in their first linked course to tax issues. The result was a software tool through the Telegram chat, applied in a case study for students of the accounting career at a Chilean university who are using remote learning methodology for COVID-19 reasons. The results obtained from the case study are promising and lead to the opening of an area of innovation in education that until years ago was not evident.

Regarding the structure of this paper, the theoretical framework that will provide the definitions and general aspects that must be taken into account is presented below; Later, other experiences applied in the subject will be seen, and then proceed with the experimental design and case study. This article ends with the results obtained and their corresponding discussion.

II. Theorical Framework

The main theoretical aspects that must be taken into account as a basis for the work carried out are presented below.

A. Remote learning (e-learning)

Remote learning through e-learning is what happens outside the traditional classroom, due to the physical separation between student and teacher, this thanks to the use of web technologies [26]. Understanding the importance of effectiveness in these practices is crucial for the global contingency that the educational system faces. As a consequence of quarantines applied in certain communities, the development of e-learning is presented as an intelligent solution to avoid the paralysis of some elementary activities in our development.

Common adoptions to observe are the increasing number of virtual classes, communicational applications and security measures that have had to be considered [27]. Also, they must be complemented with different techniques to promote a pleasant environment for students, for example, cooperative approaches, where the student-student approach and relationship are not lost, or classes where the teacher uses the switched on the video camera to a teacher-student approach [28] this becomes more important in introductory or primary courses since many times students do not know their new classmates and generating some degree of connection between them becomes more complicated.

B. Chatbots

A chatbot is a software tool that allows users to have a conversation between a human and an artificial entity [25]. For this, messaging applications such as Facebook Messenger, Telegram or WhatsApp are used.

To understand the essentiality and the role that chatbots play in modern life, one of the most successful software of this type in the market can be highlighted: the company Hennes & Mauritz AB, taking care of the relationship with its clients, offers a program that can interact with people [26], the main objective of this is to replicate a human conversation to facilitate the collection of information by a customer. Certain factors help the implementation of these systems within our community, such as the fact that they are designed and developed so that it is easier to speak to a chatbot than to a person about important topics and that the chatbot provides answers. automatic when support people are not available [27].

In a macro aspect, it can be seen how the development of this new modality of community-organization interaction has been massified at such a level if it is a necessary step to identify elements of growth in a business, a business sector or organization [28], and in this way use the chatbot as a solid component in the competition between companies, markets and sectors [29], in addition to connecting with the key components for the success of collecting real, updated and specific information [30].

To meet the modern demands of the market, chatbots, specialized in providing a natural language interface for their users, have become a popular tool for increasing development and implementation on the internet. The applied designs are becoming more sophisticated and complete [31], playing a wide range of roles within the community and organizations, within which we can highlight education support [32], entertainment [33][34], health [35], governments [36] and customer support [37].

C. Chatbots in education

The search for new more effective teaching methods has caused technology to take center stage in student service. Ubiquitous tool-based learning has been a barrier that the current situation has had to go through abruptly [38], and the implementation of chatbots has not been the exception [39]. The effects of online learning vary considerably from traditional ones, for this reason it is that chatbots aimed at education should be structured to maximize the benefit of students when studying through them, other studies declare that students find this teaching method attractive and useful [40], in addition to meeting the necessary conditions to meet the academic demands of the students [41].

There are three factors regarding commitment and motivation: performance expectation, effort expectation, and habit [42], indicating that commitment is linked to benefits versus the effort students are subjected to when supplementing their learning with a chatbot system.

D. Decision trees

Decision trees are data structures with high complexity, but massive use in different areas. This type of data structure shares much of its definition with binary trees, and even with search binary trees, commonly used in computer engineering and data science. [43], [44]. For this reason, this type of tree is also characterized by storing its different nodes in a hierarchical and ordered manner under a defined criterion based on the problem addressed. Compared to linked lists, queues or stacks, in this

case, the data is not stored linearly [45]. In this case, the constraints that will be applied to the decision tree have unique key control N-ary tree characteristics as used in search binary trees. The paths and handling of the decision tree structure are delivered to the natural language processing engine as shown below.

The decision tree used was treated as a map of possible outcomes of a series of decisions related to intentions with their associated probability. Intention management is left out of the analysis of this article. Figure 1 shows an example of an applied decision tree.

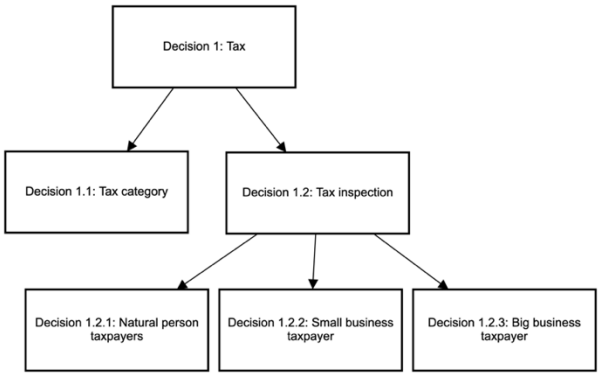

Fig. 1. Decision tree example.

Decision trees start with a single node and then branch out into possible outcomes based on intent analysis by the natural language processing engine [46]. Each of the results creates additional nodes which iteratively branch into other possibilities represented by other nodes. In this case, the decision node will represent the intention in which the interaction delivered by the user will be classified, leading to the existence of a terminal node which will show the result of the intention.

III. Related Works

In the first instance, the section of works related to education in business careers will be appreciated, to later talk about educational experiences under the restrictions imposed by COVID-19. It will continue with the exhibition of those works about the teaching of tax matters to end with experiences using chatbots.

A. Business education

One of the objectives of education is preparation for the world of work, in [22] the question arises as to whether accounting graduates meet the expectations of employers. In their results they reveal the differences presented between the education provided and the skills that employers look for in graduates, proposing that a greater emphasis should be given to the generic skills of students, including teamwork, leadership, communication Verbal and interpersonal skills as the most important, since it is assumed that the technical knowledge at the time of graduation is of excellence. In the paper of [23] it delves further into the skills and attributes that a student should have, giving a perspective of the student and recognizing that the student is becoming concerned about the expectations that employers have about them; In this work, it is appreciated that continuous learning is something highly valued, and in this way, it seeks to develop communication, analytical and decision skills, as successful approaches for the preparation of students related to accounting. This can identify a clear gap in accounting education that must be addressed, [24] He mentions that the gap has 3 primary causes, (i) differences between what educators and employers believe necessary in the learning process, (ii) institutional and student factors, and (iii) poor performance by educators. Also, this paper mentions the lack of interest in solving the fact that students find accounting classes boring and do not encourage interest in their study.

With all the knowledge about gaps in the education of accountants, the need for a change in the education system becomes obvious, however, the Australian work of [25] it exposes how a significant number of accounting schools resist the adoption of new technologies to create solutions to the problems mentioned above. The reasons for this are explained by the lack of interest in implementing technologies with an extra workload, the little support and the lack of resources are also presented as important factors, but the one that is most considered in the results is the lack of Educators' time to learn and develop skills and competences with which they can efficiently adopt new technologies in educational systems. The work recommends considering a new model that reflects current technological innovations to provide education, anywhere, at any time, and for anyone.

B. E-learning in times of COVID-19

In times of confinement as a consequence of COVID-19, concern for students and educators becomes evident, as stated in the article by [55], in this work, a survey was conducted for students, residents, and medical colleagues, noting that residents sought to be able to make a difference in the system, but were still afraid of how the program would develop and of the unknown barriers by which They would confront each other, also sought less frequent access to patient rooms to reduce their exposure to the virus, and students are concerned that they may not be able to help when they feel morally and ethically inclined to do so. In the work of [56] it is exposed as the students who need academic support during the pandemic, have ineffective learning strategies, little motivation when developing their classes, and poorly developed communication skills. Resolving that it is important to direct the transformations of education in a digital trend.

In [57] they put alexithymia on the table within the contingency, where students present mental health problems from their homes due to quarantine effects during the pandemic in China. At work, they resolve alexithymia highly associated with depressive symptoms during COVID-19. We can also see the determinants of depression in the work of [58] aimed at determining levels of depression and related societal factors that are affected by COVID-19. Higher levels of depression are seen in unmarried women between the ages of 18 and 29 who are currently studying and have less income than the expenses they are incurring. Anxiety is also an important element in the participants observed in this work.

C. Learning about tax matters

The work of [47] mentions how tax education faces significant challenges in the 21st century and delivers results to change current educational paradigms, inciting more effective

conceptual knowledge-based teaching practice over technical ability. In [48] it is exposed as the tax matter is elementary to complement other subjects within accounting programs, and it is sought to find effective teaching methods, among which the computational use is presented, which although it presents good results, its implementation for the date.

In the work of [49] it is shown that learning taxes is necessary even in non-accounting programs since it provides results on how graduated individuals who had a low level of knowledge regarding taxes would like to learn about the subject to give it utility in their working life, and he believes that the best time to instill learning this is at the tertiary level. Based on the fact that all the inhabitants of a national territory must contribute by paying taxes, and it is something that concerns everyone, regardless of whether or not they have studied accounting related subjects.

Finally, the work carried out in the Czech Republic by [50] mentioning that we must face frequent changes in tax legislation and the state's approach to tax policy when teaching them at the tertiary level, worrying about the level of knowledge of students in these subjects. In their results, they obtain that the extracurricular students have the best results regarding the level of knowledge in the subject, exposing that a factor that influences this fact is that the majority of the extracurricular students already have a job.

D. Use of chatbots in the learning process

As mentioned in [55] Chatbots as learning tools are still in their early stages. His study evaluates the appropriateness of these systems for their application in education based on seven principles of a good education, the results show that this practice has 5 principles to improve the traditional course of teaching, so its implementation concludes an improvement in the educational system. However [56] exposes that the E-Learning methodology can cause feelings of isolation and detachment caused by the lack of interaction with teachers, even so, for this, they propose a solution, which aims to create a "hybrid chatbot" that is capable of reducing these negative feelings. The responses generated are close to what a real human would say in said situation, providing more interesting conversations that keep the student's attention.

Other studies such as that of [57] they support the use of chatbots in education as an innovative learning technique, showing that it is strong support for both students and teachers. Also, they advise the use of “LINE Chat Application” in the implementation of the chatbot, because it makes it easier to read materials and execute exercises. In [58] it can be seen how the implementation of chatbots is constantly being developed for its implementation in Bengali education, where its objective is to create a chatbot with a precise and wide knowledge base that efficiently serves the student sector.

IV. Proposed Solution

In this chapter, the aspects that make up the proposed solution to the defined problem will be appreciated. This solution was addressed to university accounting students who are in an e-learning modality due to the distancing established by the government due to the pandemic produced by COVID-19. The focus of learning is related to tax regulations.

A. Objective of research

The objective of the research is to study the effectiveness in the learning of tax regulations in accounting career students through the use of a chatbot based on decision rules under the e-learning context.

B. Research questions

The research questions asked to go along the lines of determining the effectiveness of the tool and its impact on effective learning:

1. Does the use of a chatbot contribute positively to learning tax regulations?
2. Is learning via chatbot more effective than using e-learning videos?

C. Hypothesis

Considering all the aspects and variables described above, it can be established as a research hypothesis:

The incorporation of a chatbot for the learning process of tax regulations in higher education delivers better results due to academic performance by students.

D. Solution generated

To respond to the stated objective, a chatbot was designed based on a decision tree focused on knowledge of tax regulations under the Chilean legal context. Also, the different tests and activities were designed to demonstrate the interaction and check the effectiveness of the tool in the learning process.

E. Solution Objective

The objective of the proposed solution was the implementation of a chatbot with pedagogical resources, which, using decision trees, could be applied in the context of tax regulations at the university level for students with distance learning as a product of confinement COVID-19.

F. Pedagogical context

The learning context of the tax regulations of this research focuses on the career of an accountant auditor (public accountant) of a Chilean university. Thus, the teaching and learning of the rules that regulate the tax regulations is a constant challenge, especially to achieve effective learning and that the different indicators of approval of the courses do not generate significant delays in the rates of curricular advancement of the students, and above all under a rare context in which educational entities have been forced to continue their teaching process using support tools via the Internet as a result of human confinement by COVID-19.

G. Pedagogical skills

The professional graduation profile of the career of auditor accountant (public accountant) considers the development of certain skills that are directly related to the work performed:

1. Generic Fundamental Training Competencies: Proactivity and responsibility; She carries out her work with professional ethics.
2. Specific disciplinary competences: Understand the conceptual framework of the current internal tax legislation.

3. Specific professional competences: Apply the conceptual framework of the current internal tax legislation.

H. *Objectives learning (OL)*

The learning outcomes associated with the experiment and the course are:

1. OL1: Defines the types of tax inspection to identify the procedure that applies to each of them.
2. OL2: Includes the indirect control rules for their correct application in the taxpayers' life cycle.
3. OL3: Understand the direct control rules to identify the rights that assist taxpayers.

I. *Contents*

The course of Taxation 1, of the career of auditor accountant (public accountant), has a structure of contents that pay tribute to the learning results, in this way, the contents associated with this experiment are:

- Understanding of tax regulations, their practical application in the taxpayer's life cycle.

V. Case Study

A. *Methodology*

For methodological purposes, we worked with the Taxation 1 course of the accountant auditor career, where the main subject of this course is the regulations on corporate taxes. The experimentation process can be seen in Figure 2.

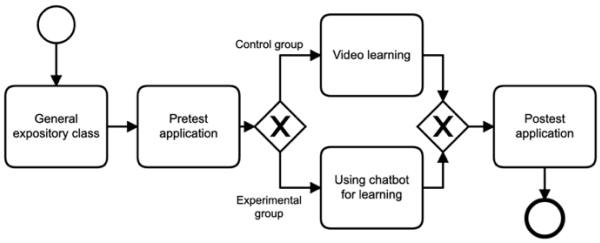

Fig. 2. Methodological process of the experiment.

Firstly, a theoretical content class is carried out with the full course without differentiating or separating individuals. This class is massive and is conducted through the Google Meet platform for students. After that, a pretest is applied to all the students based on the contents taught in the classroom. Then, the course is divided into two groups, which we will call the experimental group and the control group. In the case of the control group, the use of videos was applied through the Moodle platform, and in the case of the experimental group, the use of the chatbot was applied. Finally, the same post-test is applied to both groups to measure the difference that is generated in the learning process.

With this, the results obtained in the tests by each of the groups will be compared and the effectiveness of the use of the chatbot will be evidenced. Finally, it should be noted that, of the total of 16 students, 8 remained in the experimental group and 8 in the control group.

B. *Interaction mechanics*

In the case of the students belonging to the control group, explanatory videos were recorded with the contents, given that it is one of the techniques most used by universities to deal with learning under COVID-19 restrictions. Figure 3 shows an example of a video used with the experimental group.

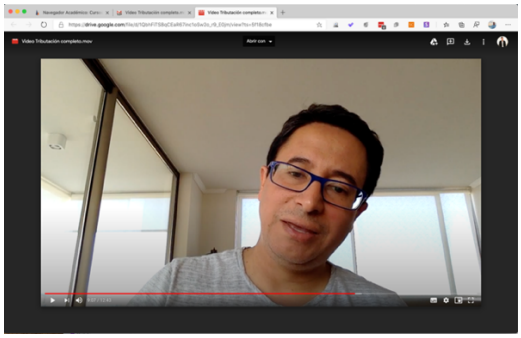

Fig. 3. Video learning example.

A guide to questions to be solved with the support of the bot was delivered to the experimental group. The chatbot used was called *Tribuchat* and linked to a Telegram chat, whereby students using their mobile devices interacted under the guidance of the chatbot. Figure 4 shows an example of interaction with the bot.

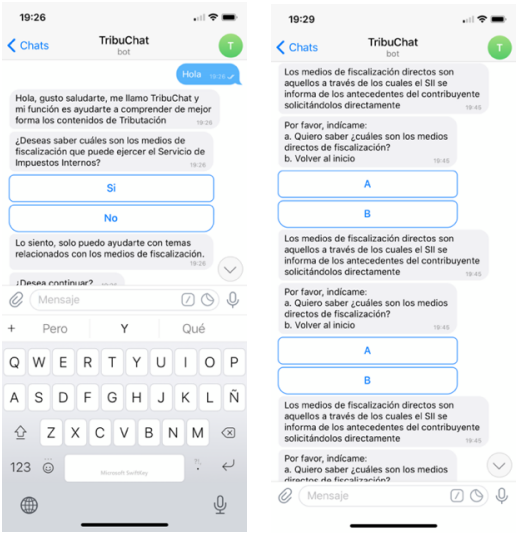

Fig. 4. Chatbot interaction example.

It is important to note that a bot feeding process was carried out, in which the teachers in charge of the subject generated the expert knowledge base in the subject and thinking about the interaction with the students, which was loaded into the SAP tool. Recast.ai. Finally, interaction actions were included to measure learning of a formative nature through questions asked by the same bot to the students.

C. *Evaluations*

As mentioned previously, there were two tests, one that was developed before dividing the group and another after to measure effective learning. An example of evaluation interaction is presented in Figure 5 and using Google Forms.

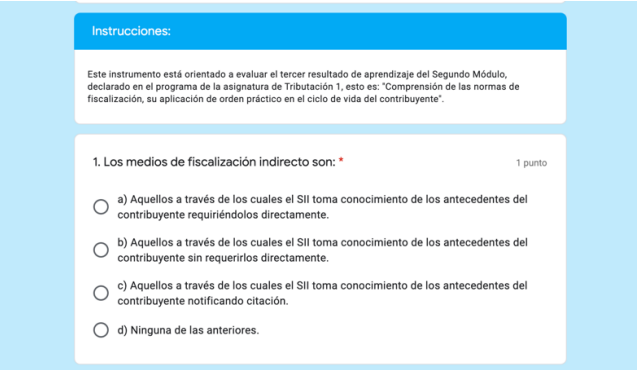

Fig. 5. Example evaluation rendered by the student.

VI. Results

Now the results obtained will be shown, for this, they will be classified in the general results, later a categorization by gender and finally by performance. Table 1 shows the results obtained in the applied tests and shows the averages of correct, incorrect, omitted responses and the percentage of correct responses obtained.

TABLE I. General results

Group	Clasification	Pretest	Postest
Control	Correct	7	7,125
	Wrong	5	4,875
	% correct	58,33%	59,38%
Experimental	Correct	6,125	8
	Wrong	5,875	4
	% correct	51,0%	66,7%

Table 2 shows the characterization of the groups based on composition according to gender.

TABLE II. Characterization by gender.

Group	N	Male	% Improvement	Female	% Improvement
Control	8	25%	0%	75%	2,3%
Exp.	8	37,5%	27,8%	62,5%	32,3%

Table 3 shows the behavior of groups according to the mean. For this, those who are below the mean, equal, and above are grouped in their experimental and control group categories.

TABLE III. Behavior of groups according to the average

Test	Group	Referential mean	%< rm	%=rm	%>rm
Pretest	Control	7	12,5%	75%	12,5%
	Exp.	6,125	25%	62,5%	12,5%
Postest	Control	7	25%	37,5%	37,5%
	Exp.	6,125	0%	25%	75%

Table 4 shows the behavior of groups according to the learning objectives, the percentage of correct questions obtained for each learning objective is presented.

TABLE IV. Results by objective learning

Group	Test	OL1	OL2	OL3
Control	Pretest	75%	63%	48%
	Postest	81%	46%	59%
	Total	6%	-17%	11%
Experimental	Pretest	71%	54%	40%
	Postest	88%	54%	66%
	Total	17%	0%	26%

VII. Discussion

Due to what is shown in Table 1, it is evident that the control group had an advantage of 12.56% over the experimental group in the pretest, which was reversed in the posttest, leaving 10.97% at boon of the experimental group; which leads us to deduce in the first instance that if the performance of the students in the experimental group is compared with that of the control group, the chatbot tool produced an evident improvement in learning to the detriment of the control group that occupied explanatory videos. The foregoing is also supported by the differences in correct answers and in the mistakes made, where the control group shows a discrete performance compared to the experimental group.

If the behavior by gender is studied, it is essential to note that the men belonging to the control group did not show improvement (0%) compared to the men in the experimental group (27.8%). In women's case, the improvement in those belonging to the control group is only 2.3% compared to 32.3% in the experimental group. It is noteworthy that in both groups, the improvement of women is above that of men.

If the behavior is analyzed according to the means, as shown in Table 3, the control group goes from having 75% in the mean to 37.5%, leaving 37.5% above the mean versus 12.5% initial. In the case of the experimental group of 62.5% who were on the average, only 25% remained, while those who were above the average rose from 12.5% to 75% of the group, which together with the 0 % below the mean, so the effect of the applied tool in the experimental group is greater than that of the control group since many students being below the mean or in the mean rose to be in or above it. The above is an important case to highlight and take into account for later statistical analysis.

Finally, regarding the learning objectives, we find that in the learning objective the differences between the OL1 and OL3 of both groups is not a broad value. Due to the post-test, after using the tools it can be seen that the control group obtained improvements in all the results, but the improvements obtained by the experimental group are greater. In addition, the control group had a decrease in OL2 (-17%) versus the experimental group (0%).

With this, it can be comfortably established that the use of the chatbot is more effective in what refers to learning versus the modality of busy explanatory videos product of the COVID-19.

VIII. Conclusions

It is already known that the teaching of tax matters is a constant challenge that the expert teachers in the matter must face daily, this combined with the reality that the countries live

in due to the social distancing and quarantines resulting from the COVID-19, have intensified the conditions of teaching away from the ideal that we know. This is why motivation is a very relevant aspect in a time like this since it is one of the few tools that can generate an evident and significant change in student learning, which is already faced with complex issues. as is the case of learning tax regulations adding the complexity of the Chilean tax system and the constant reforms that the system has been undergoing in accordance with political and social evolution.

Throughout this paper, we have been able to see different techniques and experiences that try to improve effective learning, and even in the experiments carried out, a non-traditional technique could be contrasted with the use of the chatbot. And it could be shown that the chatbot led by a decision tree has better results than guided learning through videos. The results showed that in all cases the chatbot performs better than the other tool.

As future work, it should be taken as perspectives to analyze and quantify in a more explicit way the impact of the use of this type of tool and the cognitive load that it generates in the students. It would also be interesting to study if the chatbot's knowledge construction model has an impact on learning, for this, a quantitative comparison could be made in this regard.Finally, it should be noted that through this research it is shown that a chatbot improves the results in tax learning and, therefore, studies that cover other aspects of effective teaching and learning should be continued.

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Acknowledgments: Alexander Capdeville, Roberto Rojas, Tomás Vidal and Xavier Díaz. Research assistants of the project that made this paper possible.

This project was funded by the Vicerrectoría Académica of the Pontificia Universidad Católica de Valparaíso through the Dirección de Desarrollo Curricular y Formativo.

Rafael Mellado-Silva is a recipient of the INF-PUCV doctoral scholarship.