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ANALYSIS OF INDICATORS FOR THE IMPROVEMENT OF VIRTUAL EDUCATION THROUGH BUSINESS INTELLIGENCE TECHNIQUES: CASE FOR HIGHER EDUCATION

Javier E. Sierra[1], Santander De la Ossa Guerra[2], María F. Sierra[3]

[1]Faculty of Engineering, Universidad de Sucre, Colombia.

[2]Faculty of Economic and Administrative Sciences, Universidad de Sucre, Colombia.

[3]Faculty of Education and Science, Universidad de Sucre, Colombia.

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ABSTRACT:
The global problems because of Covid-19 led Higher Education Institutions to rethink and improve their teaching processes through Virtual Education. Higher Education Institutions do not have implemented technological tools that allow them, accurately, to carry out improvement processes that are reflected in Quality Indicators in Training. Business Intelligence enables data analysis, supporting strategic decision-making regarding Investments and plans to be carried out in training processes. In this article, through a data modeling using Business Intelligence, variables that influence the improvement of the quality of Virtual Education are determined. The results show that investing or carrying out Work Plans with Teachers participating in Innovation Projects based on the use of ICT, good practices and problem solving through ICT, and the development of support materials, among others, from the Teacher's perspective, indicators of the development of Virtual Education improve.

INTRODUCTION:

The Covid-19 pandemic has forced the Educational System to reevaluate itself and generate new Training Strategies, mainly through Virtual Education (Kexin et al., 2020). In the Educational System, social skills are increasingly important, since they allow Teachers and Students to adapt to new challenges, as well as guarantee an independent education and lifelong learning(Supriyatno & Kurniawan, 2020). From this, different Training Strategies have been generated that include the use of Social Networks, new Contents and Apps. Virtual

Education will remain for several years, even when the pandemic is fully controlled(Xiao & Li, 2020).

The rapid changes in the Educational System have motivated Higher Education Institutions to have to modify their Training processes and, consequently, make Investments, both in Technological Infrastructure to support Virtuality and Training Plans for Teachers, which have a positive impact on better Quality Indicators in Training. Higher Education Institutions require technological tools that allow them to make strategic decisions to make their Investments, also given the economic crisis they are suffering from the pandemic(Kamil et al., 2020; Rassudov & Korunets, 2020).

Business Intelligence (BI) is the set of processes, applications and technologies that facilitate the quick and easy obtaining of data from the Management Systems of a Company for analysis and interpretation, so that they can be used for taking decisions and become knowledge for business managers(Duan & Xu, 2012). BI has been implemented in some Higher Education Institutions, mainly for the financial analysis regarding the demand for the different programs (Guerrero & Sierra, 2018).

In this article, a BI implementation model is established based on information available in databases of a Higher Education Institution and results of surveys and Teachers' perception. The model contemplates the prioritization of objectives for the Institution in that it wishes to improve rapidly with the implementation of Virtuality. The model considers the competencies and abilities that the Teachers have, and allows to analyze which are the variables that have the greatest impact on the quality objectives prioritized by the Institution. The results of the model will allow the Institution to make a strategic decision for the development of Training and Investment Plans.

BACKGROUND:

Implementation Of Virtuality in Emergency Covid-19:

Technological advances have been important worldwide, especially about the Educational System. Learning processes or acquisition of knowledge, skills, values, beliefs, and habits have been transferred to virtual platforms and this has generated different investigations. Khanna et al (2020) study the technological problem created from the fact that Students should not attend Institutions. They analyze the issue through surveys, and seek to identify Internet connectivity problems, and basic understanding of technology and other similar problems (Khanna & Prasad, 2020). Leksono et al (2020) carry out an investigation regarding the effectiveness of Online Learning using media such as Webex, Google Zoom, Google Meet. They compare Online Learning with Project-Based Learning (PBL) with a research sample made up of the control class and the experimental class(Edy et al., 2020). Liu et al (2021) analyze a new teaching model combining "online and offline integration", optimizing and adjusting it, and develop an effective online inverted combined mode based on SPOC (Small Private Online Course: Private Broadcast Course) already From this they achieve efficient teaching results in real time(Liu et al., 2021). Ojugo et al

(2021) carry out a study that seeks to determine the relevance of some textbooks used in the teaching of Science, Technology, Engineering and Mathematics in Tertiary Institutions in the state of Delta. From the study, they redefine the educational objectives to face Globalization as a means of interconnection and unification, and, in this way, improve the quality of Student Education (Ojugo & Yoro, 2021).

Attallah (2021) conducts an investigation on the literature related to the experiences of universities in the post Covid-19 stage in the application of virtual worlds and applications in Higher Education around the world, to achieve Remote Learning developed for Students in a risk-free educational environment. The article highlights the advantages and importance of Virtual World Technologies for the requirements of Higher Education in this period, and provides examples of Universities worldwide, which applied virtual worlds and applications in the education of their students after the pandemic. The document also offers recommendations to Higher Education Institutions when considering Virtual World Technologies for their Online Learning activities(Attallah, 2021).

Business Intelligence Applied in Higher Education:

The concept of Business Intelligence has been widely used by different companies to improve strategic decision-making. However, its use to improve academic quality has not been as widely used. Some authors have used it in Higher Education. Next, we identify some jobs.

Alowaigl et al (2021) examine numerous criteria for decision support systems in the educational setting. In the research they discovered and applied two effective methods: the Analytical Hierarchy Process (AHP) and the Simple Multiple Attribute Classification Technique (SMART). The performance of the methods is compared using two Data Sets called Data Sets x Api-Education and IPEDS(Alowaigl et al., 2021). Rokade et al (2019) carry out a study and analysis of people's feelings, evaluations and impressions about entities, people, events, topics and services (Sentiment Analysis - SA). SA uses text analysis techniques and natural language processing methods to locate and extract information from Big Data. The authors focus on understanding the fundamentals of Sentiment Analysis; the techniques used for the extraction and analysis of feelings. The techniques are then compared for precision, advantages, and limitations(Rokade & Aruna Kumari, 2019).

RESEARCH METHOD:

The starting point of a Business Intelligence model is the process known as ETL (Extract, Transform and Load). In the Extraction Process, data is obtained from the different sources or information systems of the University Institution (databases, ERP, Excel files, evaluation systems, surveys, others). After its transformation is carried out, the data is validated and cleaned, becoming structured information. This is later loaded into a common place known as the Data Warehouse, which is a data warehouse that houses the unified, purified and consolidated information, ready for exploitation. Figure 1 shows the stages corresponding to the ETL process.

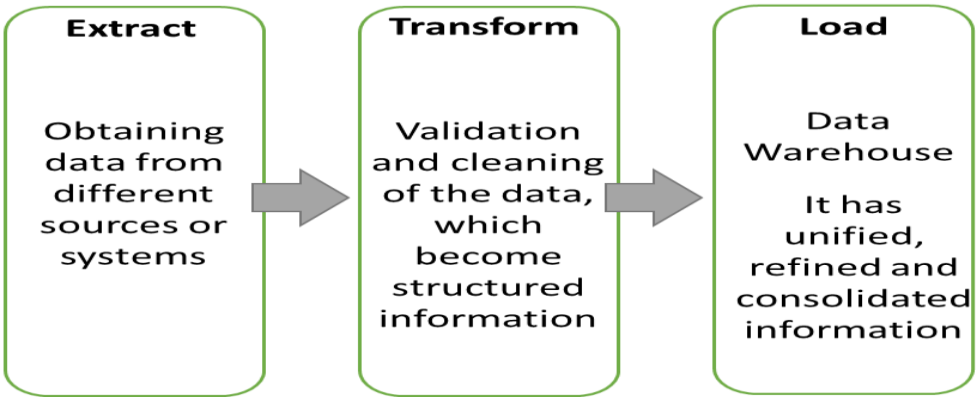

Figure 1. ETL Process to Conduct Business Intelligence

The proposed Business Intelligence model extracts the information from the Data Warehouse to carry out the pertinent analyzes and reports through the selected tool.

The complete model is shown in Figure 2. It is observed that the configuration of the ETL process is carried out, in such a way that the active directory available to the University Institution can be used to identify the Professors. In this way, it is established, through the extraction of information, basic and demographic data from them, as well as the knowledge/skills/competencies that it has. Table 1 shows the respective indicators of this information.

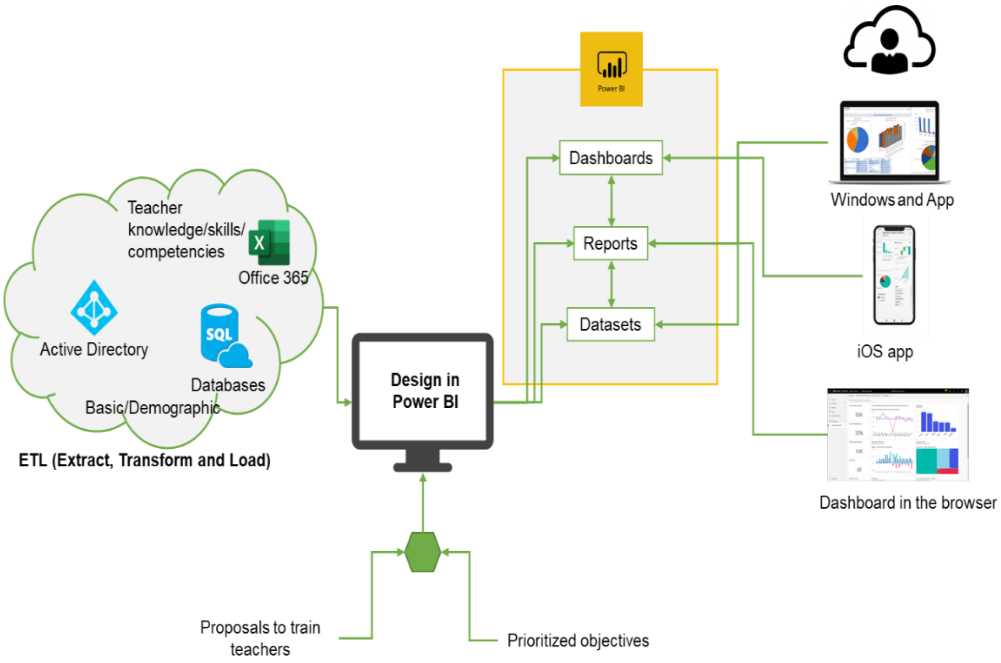

Figure 2. Proposed Business Intelligence Model

Table 1. Indicators Regarding Teachers

Indicator Type	**Indicator**
Basic/Demographic	Age
	Highest level of studies achieved
	Type of contract
	Years of experience in Higher Education
Knowledge/skills/competencies of the Teacher	Knowledge and use of the basic components of ICT
	Knowledge and use of management platforms (Moodle, Blackboard, other virtual platforms)
	Knowledge of Personal Learning Environments
	Use of digital content as support within the classroom (Online presentations)
	Training received in ICT through e-learning or b-learning
	Knowledge of "good practices" through ICT
	Training received in the use of mobile devices as a pedagogical resource
	Training in software dedicated to research and data collection and processing
	Participation in Innovation Projects based on the use of ICT
	Ability to use educational cloud tools in the classroom and create an interactive learning environment with students

The Microsoft Power BI® tool was selected as a technological tool to carry out the Business Intelligence process(Microsoft, s. f.). The data from the Data Warehouse is connected to Power Bi® and in it the required configuration is made to determine key influencers for the improvement of the quality of Virtual Education, considering quality objectives prioritized by the University Institution. Table 2 shows the objectives defined and prioritized by the Institution.

The technique used to identify the key indicators that help improve the Quality of Training is called the key influencer in Power Bi®, which helps to recognize the factors that control a metric of interest (prioritized objectives). Analyze the data, rank the factors that are important, and show them as key influencers. The key factors that are of interest to the study, as indicated by the University Institution, are shown in Table 3. The key influencers allow us to see what

factors affect the metric being analyzed and to compare the relative importance of these factors.

Table 2. Objectives Prioritized by The Institution

Objective 1	Improve the implementation of experiences and creation of learning environments with ICT - Personalized Educational Environments
Objective 2	Improve ability to create a collaborative environment in the Virtual Classroom and outside of it
Objective 3	Perfect the approach and use of MOOCs as a complementary resource in student learning on a specific topic of the subject
Objective 4	Improve ability to use ICT as a pedagogical resource
Objective 5	Develop the teacher role as guide, mediator and learner of the teaching-learning process, bidirectional relationship with the students

Table 3. Key Analysis Factors

Key Factors	**Indicator**
Required Training	Use of ICT in a collaborative way
	Preparation of materials through presentations, multimedia, videos, podcasts and others
	Structure activities of the subject using the virtual university campuses and the different collaborative work platforms
	Access to educational resources and structuring of activities through different devices
	Using video as classroom material for learning
	Use of virtual simulators and video games in the classroom as an educational resource
	Management and use of tools and storage within cloud environments
	Use of Social Networks as a resource in the classroom
	Self-taught ICT learning and experimentation
	Ability to solve problems through ICT
	ICT Training Courses
	Integration of ICT in the Curriculum and relationship with educational practice and curricular policy
	Lifelong learning and recycling in digital competence due to the evolution of educational technology
	Resolution of learning problems and attention to diversity through ICT
	Management and use of ICT in management and organizational processes of teaching and research tasks
	Work in personal networks and learning environments in the cloud
	Updating and self-regulation of the teacher's own knowledge in the face of ICT changes within the educational field

The configuration of the system allows the creation of reports and dashboards so that the people in charge of decision-making in a University Institution can

have indicators to carry out their plans or actions in a more concrete way. Reports and dashboards can be viewed on different online devices, using mobile phones, tablets, or computers.

RESULTS AND DISCUSSION:

Accompanied by the proposed model, a dynamic dashboard was built in the cloud with the information obtained from the Data Warehouse. The dashboard allows you to filter by parameters of interest, as well as to click on a graph to see the behavior of the others. Figure 3 shows the main dashboard for the representation of the data obtained.

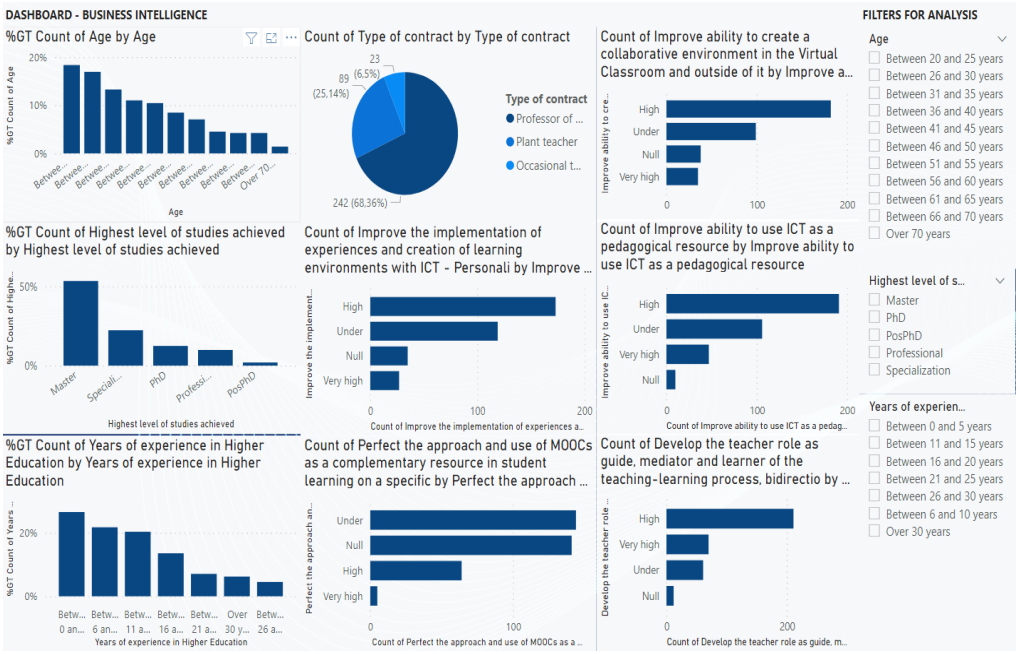

Figure 3. Main Dashboard Established for The Institution

With the data loaded, the relationship with i) the Basic/Demographic data of the Teachers, ii) the knowledge/skills/competencies of the Teacher and, iii) the training required for the Teachers is analyzed for each one of the prioritized objectives. All these factors have an impact to a greater or lesser extent on the fulfillment of the Objective and the established model allows us to identify what they are. It is shown below for each of the objectives.

Objective 1. Improve The Implementation of Experiences and Creation of Learning Environments with ICT - Personalized Educational Environments:

Regarding Objective 1, it is evident that to "Improve the implementation of experiences and creation of learning environments with ICT - Personalized Educational Environments" at a very high level, the type of contract (chair) directly impacts at 5.79x, as well as the Age between 36 and 50 years in a 3.06x. Figure 4 shows the results.

When analyzing on the same Objective (Figure 5), variables related to the teacher's knowledge/skills/competencies, results were generated that indicate that for Objective 1 to be achieved at a very high level, indicators such as: 1)

Use of digital content as support within the classroom (21.13x), 2) Participation in Innovation Projects based on the use of ICT (18.21x), and 3) Knowledge of Good Practices through ICT (16.3x), generate a greater positive impact on the Objective.

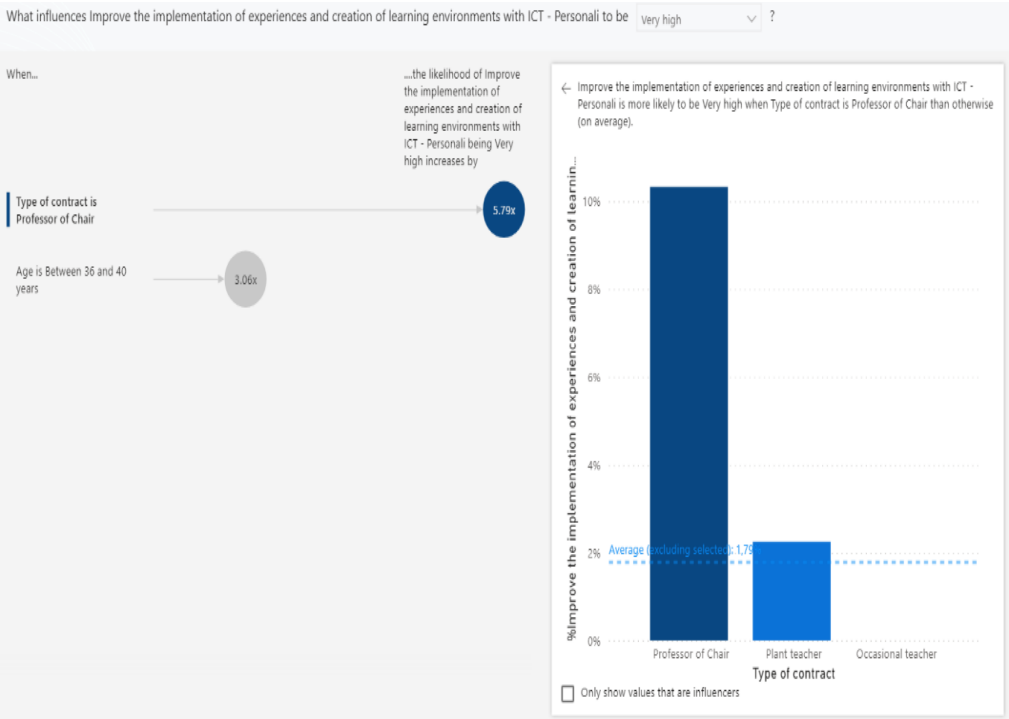

Figure 4. Influence On Objective 1 From the Basic/Demographic Data of The Teachers

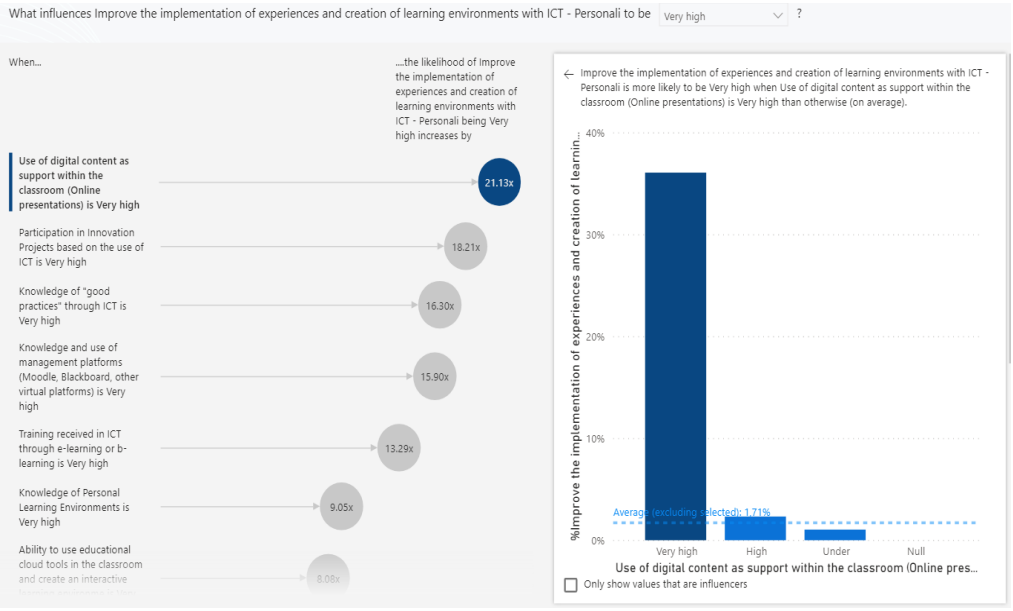

Figure 5. Influence On Objective 1 From the Teacher's Knowledge / Skills / Competencies

For the establishment of training plans, it is evident in Figure 6 that for this Objective topics such as: 1) Use of ICT in a collaborative way (26.72x), 2)

Preparation of materials through presentations, multimedia, videos, podcasts, others (20.72x), 3) Integration of ICT in the Curriculum and relationship with educational practice and curricular policy (17.98x), 4) Ability to solve problems through ICT (17.78x), and 5) Self-taught ICT learning and experimentation (15.87), generate a greater positive impact for the fulfillment of Objective 1.

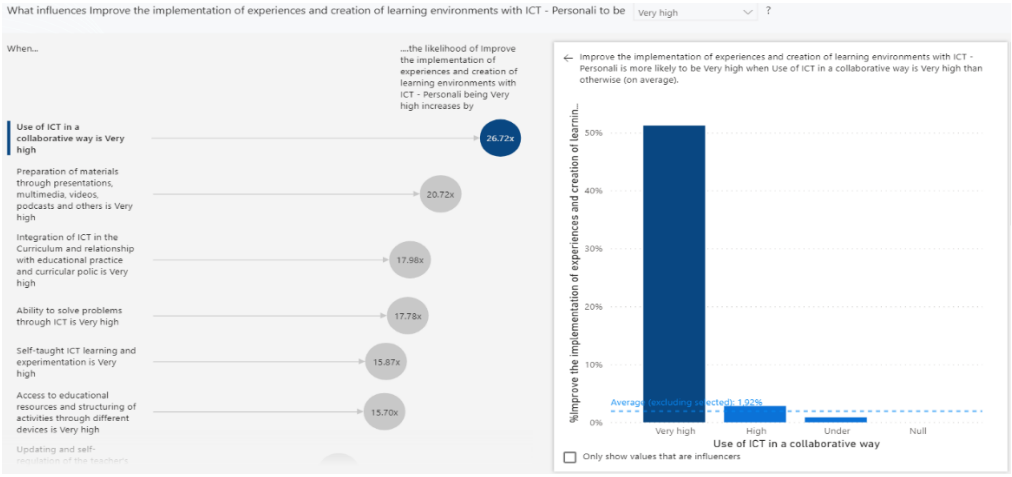

Figure 6. Influence On Objective 1 From Required Training for Teachers

Objective 2. Improve Ability to Create a Collaborative Environment in The Virtual Classroom and Outside of It:

Regarding Objective 2, it is evidenced that in order to "Improve ability to create a collaborative environment in the Virtual Classroom and outside of it" at a very high level, the type of contract (chair) directly impacts at 4.94x, as well as the Age between 0 and 5 years on a 2.07x. Figure 7 shows the results.

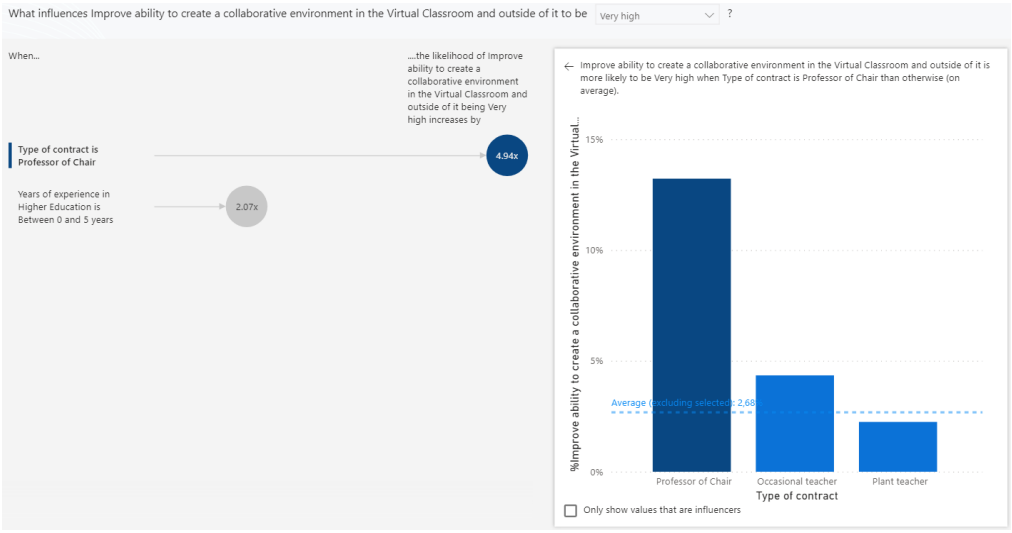

Figure 7. Influence On Objective 2 From the Basic / Demographic Data of The Teachers

When analyzing on the same Objective (Figure 8), variables related to Teacher knowledge/skills/competencies, results were generated that indicate that for Objective 2 to be achieved at a very high level, indicators such as: 1) Knowledge

of the good practices through ICT (10.58x), 2) Participation in Innovation Projects based on the use of ICT (8.95x), and 3) Knowledge about personal learning environments (7.78x), generate a greater positive impact on the Objective.

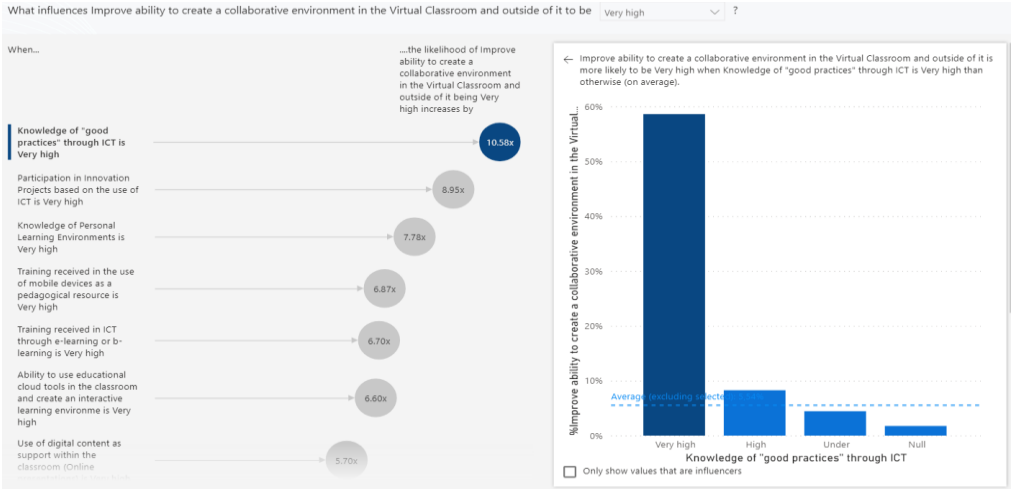

Figure 8. Influence On Objective 2 From the Teacher's Knowledge / Skills / Competencies

For the establishment of Training Plans, it is evident in Figure 9 that for this Objective topics such as: 1) Access to educational resources and structuring of activities through different devices (13.28x), 2) Structure activities of the subject using virtual university campuses and different collaborative work platforms (12.82x), 3) Integration of ICT in the Curriculum and relationship with educational practice and curricular policy (12.53x), 4) Use of video as classroom material for learning (10.20x), and 5) Management and use of ICT in management and organizational processes of teaching and research tasks (9.65x), generate a greater positive impact for the fulfillment of Objective 2.

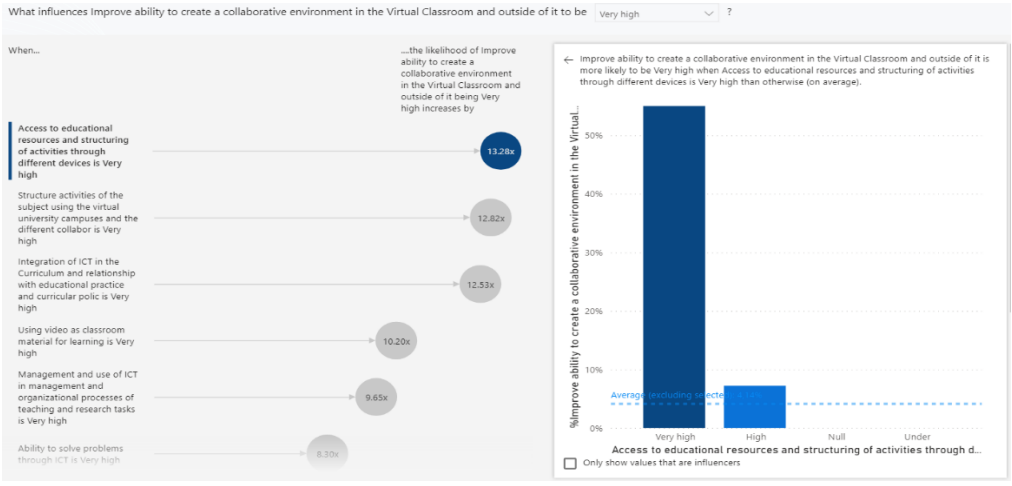

Figure 9. Influence On Objective 2 From Required Training for Teachers

Objective 3. Perfect The Approach and Use of Moocs as A Complementary Resource in Student Learning on A Specific Topic of The Subject:

Regarding Objective 3, it is evident that in order to "Perfect the approach and use of MOOCs as a complementary resource in student learning on a specific subject of the subject" at a high level, Age between 36 and 40 years old mainly impacts with a 4.94 x, as well as the type of contract (chair) at 1.82x. Figure 10 shows the results.

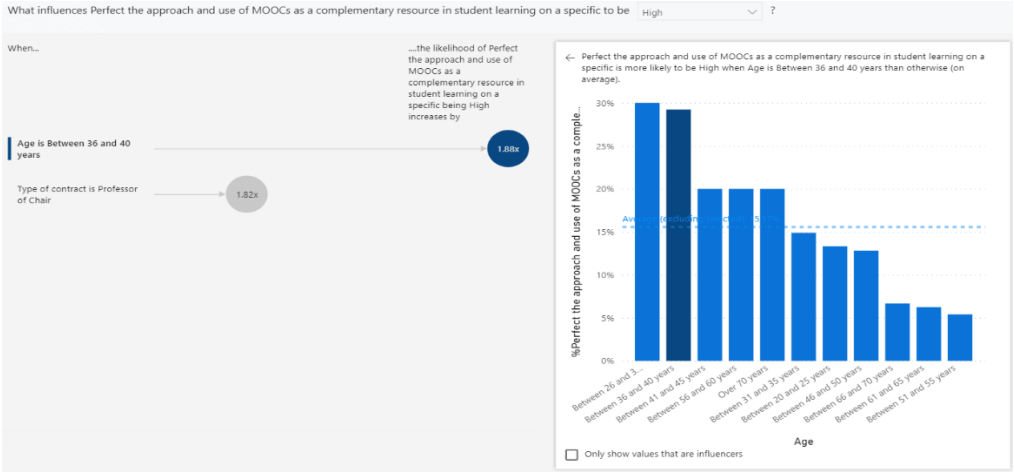

Figure 10. Influence On Objective 3 From the Basic / Demographic Data of The Teachers

When analyzing on the same Objective (Figure 11), variables related to Teacher knowledge/skills/competencies, results were generated that indicate that for Objective 3 to occur at a very high level, indicators such as: 1) Participation in Projects of Innovation based on the use of ICT (64.88x), 2) Training received in the use of mobile devices as a pedagogical resource (52.64x), and 3) Knowledge of Good Practices through ICT (44.83x), generate greater positive impact on the Objective.

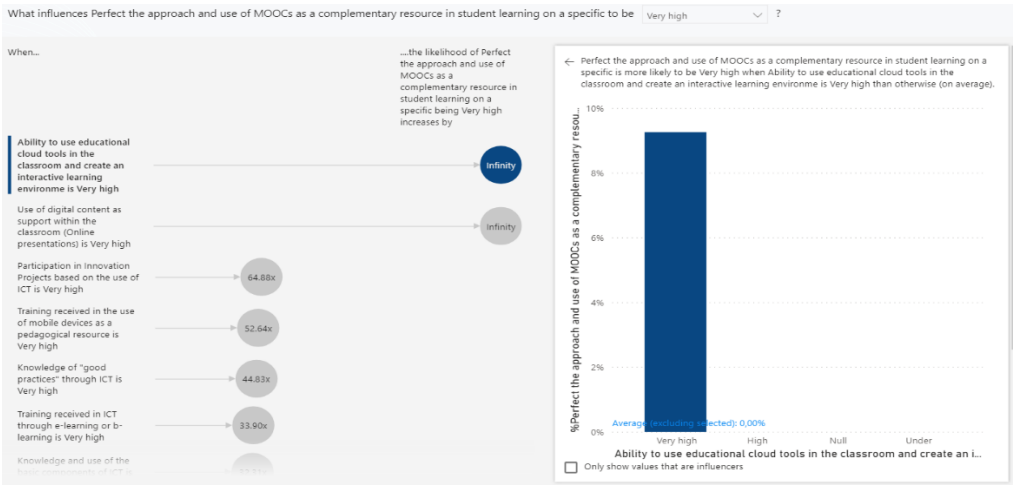

Figure 11. Influence On Objective 3 From Teacher Knowledge/Skills /Competencies

For the establishment of Training Plans, it is evident in Figure 12 that for this Objective topics such as: 1) Updating and self-regulation of the Teacher's own knowledge in the face of ICT changes within the educational field (infinite), 2)

Management and use of tools and storage within cloud environments (infinite), 3) Preparation of materials through presentations, multimedia, videos, podcasts, others (infinite), 4) Ability to solve problems through ICT (infinite), and 5) Use of video as classroom material for learning (infinite), when they are made, they generate a positive impact for the fulfillment of Objective 3.

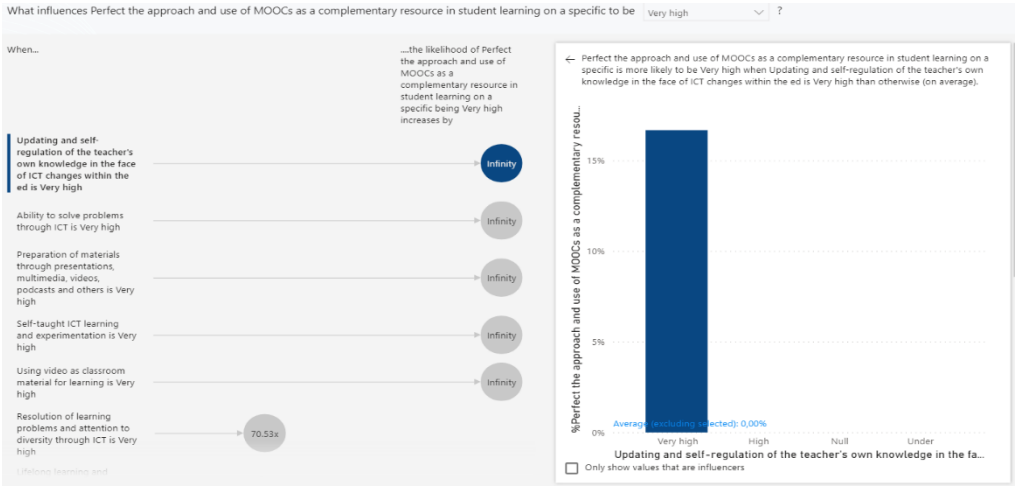

Figure 12. Influence On Objective 3 From Required Training for Teachers

Objective 4. Improve Ability to Use ICT as A Pedagogical Resource:

Regarding Objective 4, it is evidenced that in order to "Improve the ability to use ICT as a pedagogical resource" at a very high level, the type of contract (chair) directly impacts 3.16x, as well as the Age between 31 and 35 years in a 2.07x and the Years of Experience in Higher Education between 0 and 5 years in a 2.05x. Figure 13 shows the results.

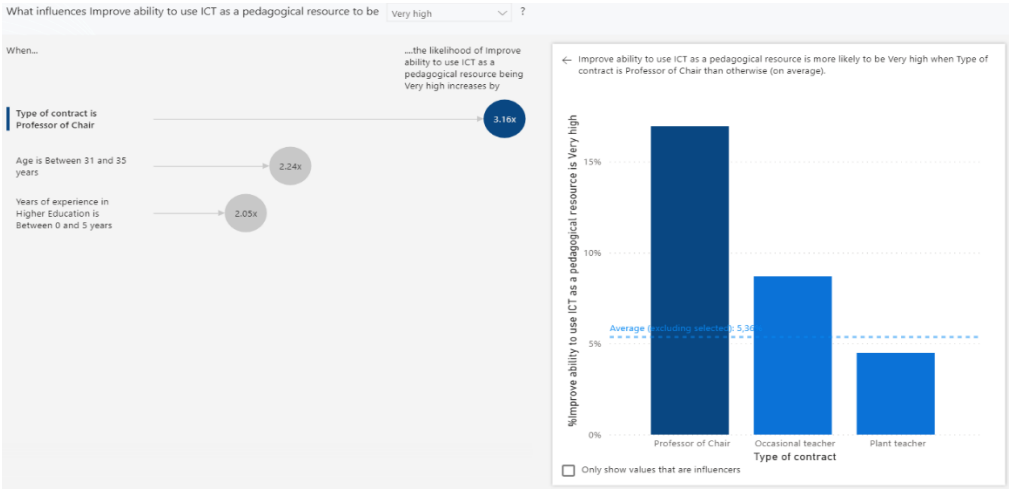

Figure 13. Influence On Objective 4 From the Basic/Demographic Data of The Teachers

When analyzing on the same Objective (Figure 14), variables related to Teacher's knowledge/skills/competencies, results were generated that indicate that for Objective 4 to be given at a very high level, indicators such as: 1)

Knowledge about personal environments of learning (7.46x), 2) Training received in the use of mobile devices as a pedagogical resource (7.46x), and 3) Knowledge and use of management platforms (5.89x), generate a greater positive impact on the Objective.

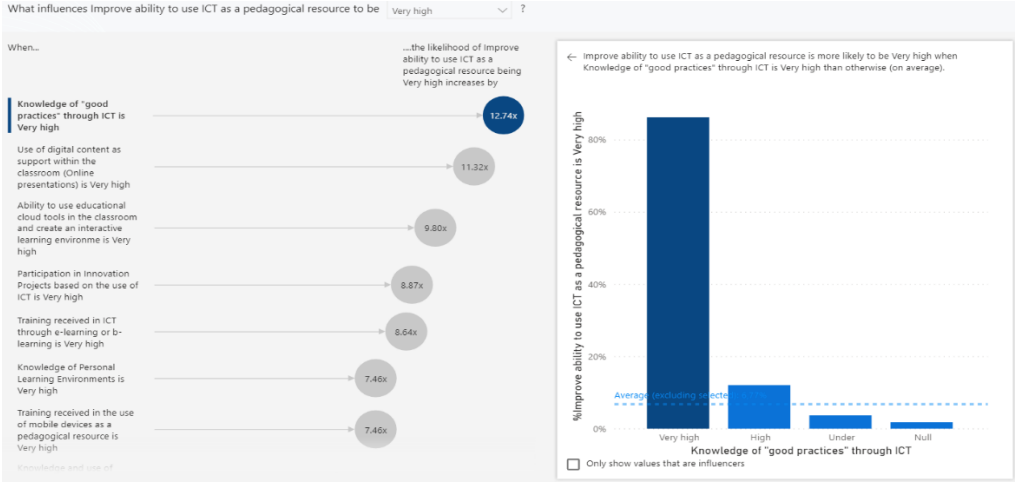

Figure 14. Influence On Objective 4 From Teacher Knowledge/Skills/Competencies

For the establishment of Training Plans, it is evidenced in Figure 15 that for this Objective topic such as: 1) Learning and self-taught experimentation of ICT (31.75x), and 2) Ability to solve problems through ICT (30.43), they generate a greater positive impact for the fulfillment of Objective 4.

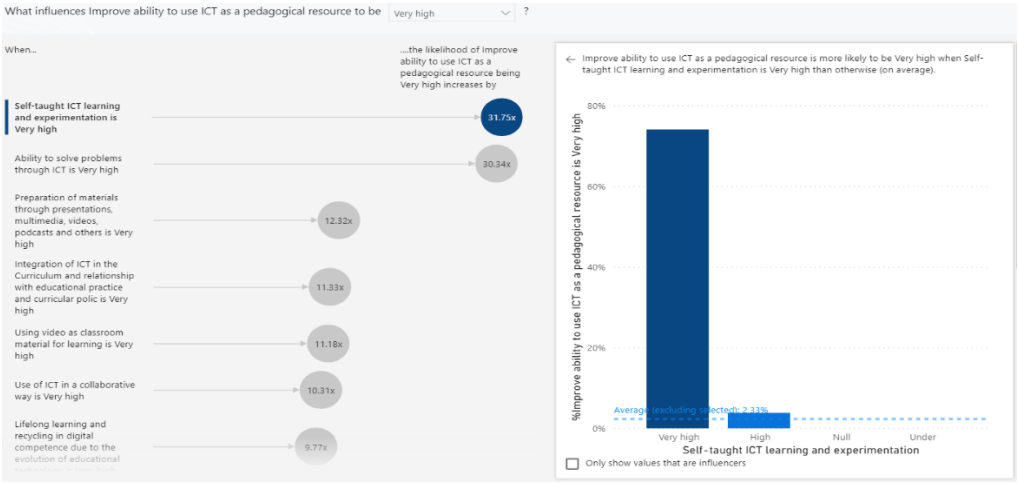

Figure 15. Influence On Objective 4 From Required Training for Teachers

Objective 5. Develop The Teacher Role as Guide, Mediator and Learner of The Teaching-Learning Process, Bidirectional Relationship with The Students:

Regarding Objective 5, it is evident that in order to "Develop the role of the teacher as a guide, mediator and learner of the teaching-learning process, a bidirectional relationship with the student body" at a very high level, the type

of contract (chair) directly impacts 2.48x, as well as the Age between 31 and 35 years in a 2.26x, the Age between 20 and 25 years in a 2.12x, and the Years of experience in Higher Education between 0 and 5 years in a 1.74x. Figure 16 shows the results.

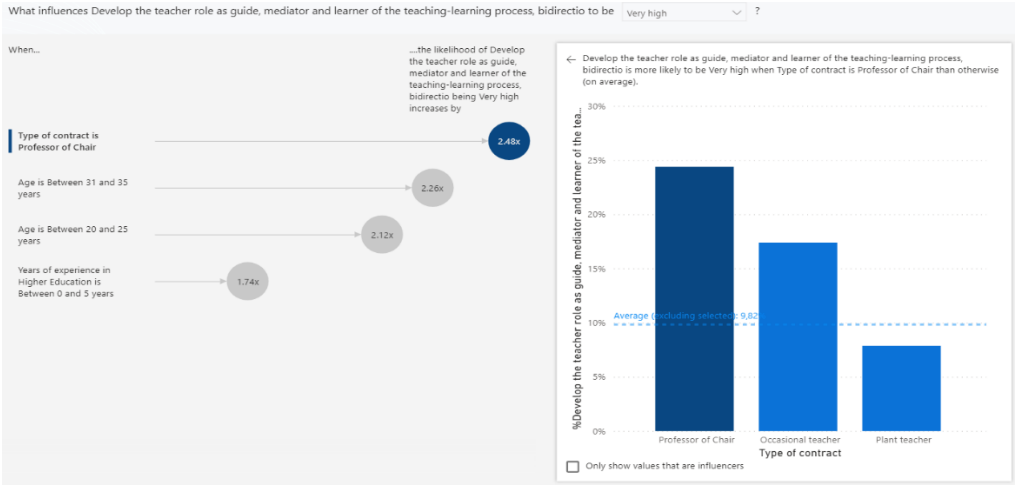

Figure 16. Influence On Objective 5 From the Basic/Demographic Data of The Teachers

When analyzing on the same Objective (Figure 17), variables related to Teacher's knowledge/skills/competencies, results were generated that indicate that for Objective 5 to be achieved at a very high level, indicators such as: 1) Ability to use the educational cloud tools in the classroom and create an interactive learning environment with students (6.23x), 2) Training received in ICT through e-learning or b-learning (5.15x), and 3) Use of content digital as support within the classroom (5.15x), generate a greater positive impact on the Objective.

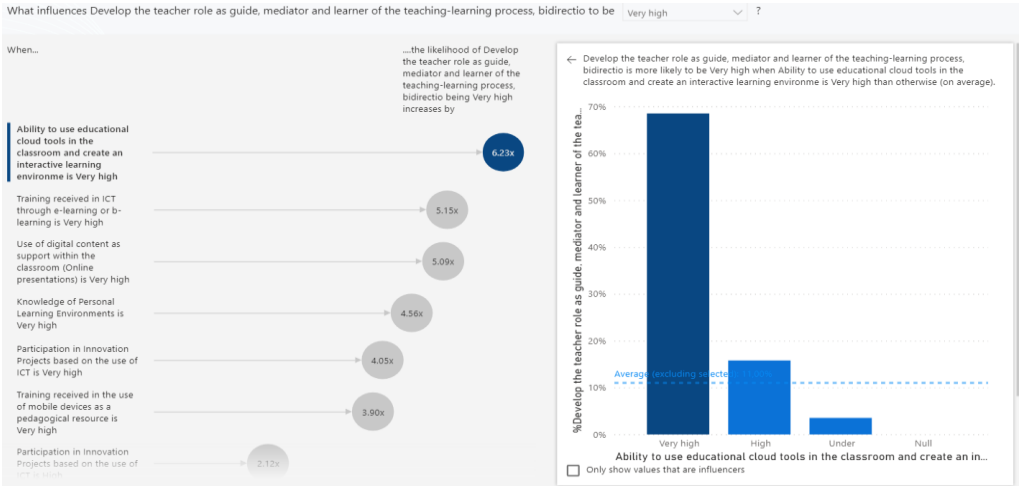

Figure 17. Influence On Objective 5 From Teacher's Knowledge/Skills/Competencies

For the establishment of Training Plans, it is evidenced in Figure 18 that for this Objective topics such as: 1) Updating and self-regulation of the Teacher's own knowledge in the face of ICT changes within the educational field (7.2x), 2)

Preparation of materials through presentations, multimedia, videos, podcats, others (5.59x), 3) Ability to solve problems through ICT (5.55x), 4) Work in personal networks and learning environments in the cloud (5.38x), and 5) Self-taught ICT learning and experimentation (5.25x), generate positive impact for the fulfillment of Objective 5.

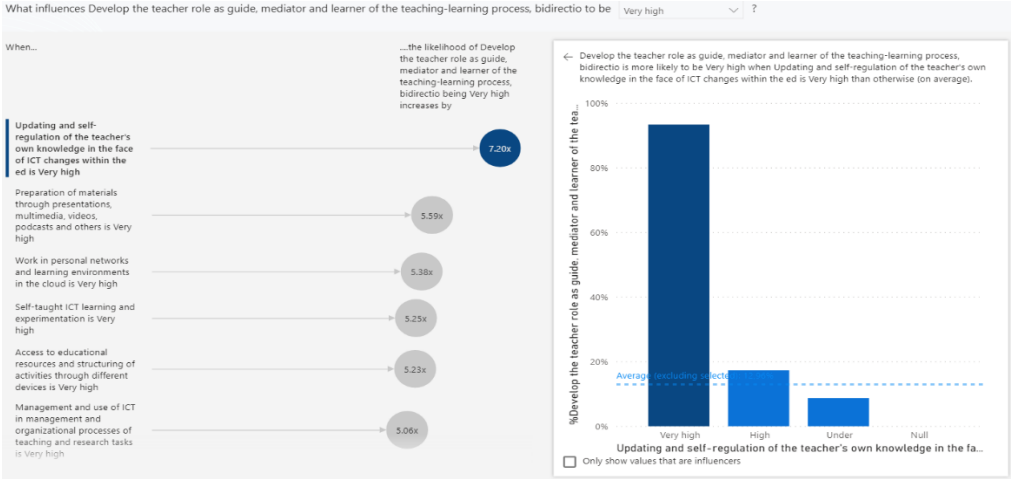

Figure 18. Influence On Objective 5 From Required Training for Teachers

When conducting a review on the indicators and factors that persist for the fulfillment of each of the objectives, the results shown in Table 4 are found, where the frequency with which each indicator is prioritized is identified.

Table 4. Frequency of appearance of each indicator

Basic/Demographic Data of Teachers	**Frequency**	**Teacher Knowledge/Skills/Competencies**	**Frequency**	**Required Training for Teachers**	**Frequency**
Type of contract (chair)	5	Participation in Innovation Projects based on the use of ICT	3	Ability to solve problems through ICT	4
Age between 31 and 35 years	2	Knowledge of good practices through ICT	3	Preparation of materials through presentations, multimedia, videos, podcasts, others	3
Years of experience in Higher Education between 0 and 5 years	2	Knowledge of personal learning environments	2	Self-taught ICT learning and experimentation	3

Age between 36 and 50 years	Non-influencing variable	Training received in the use of mobile devices as a pedagogical resource	2	Integration of ICT in the Curriculum and relationship with educational practice and curricular policy	2
Age between 0 and 5 years		Use of digital content as support within the classroom	2	Using video as classroom material for learning	2
Age between 36 and 40 years		Knowledge and use of management platforms	1	Updating and self-regulation of the teacher's own knowledge in the face of changes TIC dentro del ámbitoeducativo	2
Age between 20 and 25 years		Training received in ICT through e-learning or b-learning	1	Access to educational resources and structuring of activities through different devices	1
				Structure activities of the subject using the virtual university campuses and the different collaborative work platforms	1
				Management and use of ICT in management and organizational processes of teaching and research tasks	1
				Management and use of tools and storage within cloud environments	1

		Ability to use educational cloud tools in the classroom and create an interactive learning environment with students	1
		Work in personal networks and learning environments in the cloud	1
		Use of ICT in a collaborative way	1

CONCLUSION:

Business Intelligence is a tool that can be implemented in Higher Education Institutions for making strategic decisions, with regard to improving academic quality. Through the analysis of data from an Institution, it was possible to determine the variables that influence the improvement of the quality of Virtual Education. Results show that investing or carrying out Work Plans with Teachers participating in Innovation Projects based on the use of ICT, good practices through ICT, problem solving through ICT, preparation of materials through presentations, multimedia, videos, podcasts, others, learning and self-taught experimentation of ICT, integration of ICT in the Curriculum and relationship with educational practice and curricular policy, from the teacher's perspective, improve indicators of the development of Virtual Education.

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