

## Article

# Teachers' Perceptions Analysis on Students' Emotions in Virtual Classes during COVID19 Pandemic: A Lexical Availability Approach

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**Abstract:** Virtual education has grown exponentially in the past year due to the global COVID19 pandemic. In this context, the exploration of teachers' perceptions of their students' emotions when using ICTs has become more relevant. The aim of this study was two-fold, on the one hand, to analyze how teachers perceived their students' emotions and, on the other hand, to analyze the emotions teachers wanted to modulate in their students when using ICTs. To this end, an interpretative and comparative study was implemented using the Lexical Availability technique. The sample was formed by 178 Chilean teachers who took a lexical availability test. The analysis included general vocabulary through network graphs and a comparison across gender, academic background, school type and knowledge area. The results made it possible to identify the latent mental lexicon of teachers, revealing significant differences in the perception of emotions, according to gender and ICTs use and according to gender and knowledge area. The study further projects the potential of lexical availability to determine the emotions required by Affective Informatics in the adaptability of educational systems and to make adjustments to the instructional design.

**Keywords:** information technologies; emotions; online education; lexical availability

## 1. Introduction

The COVID19 pandemic has marked a turning point in various human activities; without a doubt, education is among the most affected ones. The dialogic and emotional processes, typical of classroom interaction, have been profoundly altered as they are necessarily mediated by digital technologies. In this way, the teaching activity suddenly faced the challenge of having to adapt its pedagogical activities, integrating Information and Communication Technologies (ICTs) to the educational process, trying not to neglect the emotional aspect widely affected by virtual teaching.

Given the vertiginous pace that the pandemic has imposed on teaching, there is a need for fast and effective methodologies that allow us to examine the effects of ICTs use on virtual teaching and the emotional interaction between teachers and students. To this end, this study uses Lexical Availability as a proposal for analyzing teachers' latent lexicon that accounts for the emotions they perceive in their students when they use ICTs in their virtual classes. Lexical Availability has been regarded as an adequate technique for this type of analysis due to its speed and precision in obtaining concrete results on the

variables being examined, providing information that will allow the teacher to make adjustments in their virtual classroom pedagogical practices to better modulate their students' emotions when using ICTs.

This research study focused on analyzing how the different groups of teachers -classified according to gender, academic background, school type and knowledge area- organize their mental lexicon around the ICTs that they have integrated into the virtual classroom, as well as the emotions they perceive in their students and those they want to modulate during virtual classes.

### *Significance of the Research Problem*

The spread of COVID19 worldwide has caused the closure of many schools and universities which led to a massive implementation of distance education [1]. The pedagogical success of this teaching modality depends widely on the strategies and methodologies used by teachers, being the use of ICTs a determining factor of this success. This determining factor requires that teachers acquire new technological skills to motivate students during their online learning process [2]. At the same time, education in times of pandemic has affected the emotional state of learners and teachers. Recent research indicates that students have experienced levels of anxiety that are higher for online assessments than for the spread of the virus, and teachers report an increase in negative emotions and a decrease in positive ones [3,4].

Distance education is closely related to the emotions and emotional changes of students [4]. For this reason, teachers need to know the pedagogical strategies that help students to modulate their emotions in the context of a pandemic [5]. In this context, it is relevant to investigate the emotions that teachers perceive in their students with the purpose of modulating them in a better way during a virtual class that incorporates various ICTs.

Countries in Latin America have scarce digital resources in education [6], which generates limited use by teachers as they do not achieve an effective integration of ICTs in pedagogical work [7]. Under this view, it is necessary to determine which technologies are used by teachers in the virtual context, firstly, to identify if they meet the needs of distance education and, secondly, to implement teacher improvement strategies in the area.

Teachers' technological knowledge and their perception of students' emotions can be investigated through lexical availability, which allows researchers to determine and analyze the available lexicon of a group of speakers [8]. The methodology of lexical availability has been used to investigate the available lexicon in mathematics [9–14], in reading comprehension [15], in English as a second language [16], in technology [17] and Spanish as a foreign language [18], mainly in Spain and Latin America [19–23]. Thus, the innovation of this study focuses on using lexical availability to examine the latent lexicon of ICTs and emotions in the context of a pandemic.

## **2. Literature Review**

### *2.1. Education and Technology*

ICTs have become one of the most impactful and revolutionary social phenomena of the 21st century. They have become essential in the main areas of daily life such as work, consumption, entertainment and skills training, turning everything into a virtual environment in constant change [24]. The ICT phenomenon has also had an effect on education, as it has demanded the mastery and integration of ICTs in teachers' practices in order to advance students' technological competences [25–27]. This is supported by different researchers who agree on the fundamental role played by ICTs in the training of students [28–30].

Pinedo [31] also highlights the value of technologies in learning and indicates that quality education requires providing teachers with tools that allow them to use ICTs to teach curricular content in a creative, dynamic, participatory and constructivist way.

These technological tools allow to complement and personalize teaching to achieve meaningful learning by motivating and encouraging the student according to their needs and characteristics. Therefore, the teacher is considered the main motivator in the use of technology in and out of the classroom [32–34] and, in turn, as the person responsible for designing learning activities that promote technological command [35,36].

At the beginning of 2020, after the spread of COVID 19, face-to-face classes were suspended in different countries, which became an opportunity to transform teaching. Thus, as suggested by Santi et al. [37], both teachers and students have been exposed to new digital experiences. This has implied great challenges for teachers, because in countries like Chile, where teachers perceive themselves as having a high technological command [38–40], a low command on ICTs has been observed in reality [41–44]. It has been observed that only a third of teachers capable of selecting, evaluating and presenting information using technologies are able to adapt a traditional classroom context to a digital one [45].

Therefore, there is a need to strengthen teaching and learning methods in relation to the use of ICTs [46,47], since their impact on the class is more related to the way in which teachers use ICTs rather than their technological characteristics [48,49]. In other words, ICTs on their own do not change the learning environment [50], that is why the teacher must integrate knowledge, context and command of ICTs in their professional development [35,51].

## 2.2. *Emotions and Technology*

Phenomena such as globalization and overcrowded classrooms require teachers to incorporate new knowledge and resources into teaching. Each student has a wealth of prior knowledge about the world, psychological and social characteristics that make them unique. They also have beliefs about the subject matter and emotions experienced when studying a particular topic. These factors make it impossible to personalize teaching, since it is complex for the teacher to manage this great number of variables and generate learning sequences that are consistent with the needs of all their students.

ICTs have proven to be efficient in personalization. An example of this is the videos, which can be watched as many times as needed. Nowadays, there are complex systems, based on Artificial Intelligence (Intelligent Tutorial Systems), that make it possible to record and recognize study times, learning achievements, learning styles and even types of intelligence. However, ICTs are not a substitute for the teacher, but rather, a tool with various features that allow the customization of teaching for the achievement of meaningful learning. ICTs can also motivate and inspire students according to their needs and traits.

The study of emotions with technologies has generated a field of study called Affective Computing [52], which seeks to use the power of emotions in intelligent educational environments. The aim is to be able to recognize emotions, using the study of language, with natural language processing techniques, sentiment analysis and lexical availability [53], as well as sources of physiological signals, such as automatic excitement, pulsations, blood pressure and skin resistance.

In this work, we focus on the study of the available emotional lexicon to analyze possible adjustments to the instructional design and to examine the possibilities that the lexical availability technique offers for the adaptability of the systems to the participants' emotional characteristics.

## 2.3. *Education and Emotions*

Several studies have reported the importance of the affective factors in the construction of knowledge [54–59]. This has not only brought about a greater interest in the study of emotions in education [60–62], but also the need to integrate the emotional dimension into the teacher professional development processes [63]. Emotions can be understood as affective, temporary and changing responses that emerge in a specific situation [58],

which are linked to school learning due to their motivating, guiding and change promoting character [64].

A key aspect of emotions is their capacity to create a predisposition to an organized response in a given situation [65]. In fact, it is according to the individual's needs or interests for acquiring certain knowledge that emotions and feelings come into play, showing that everything we do, think, imagine or remember is possible thanks to the interplay of the rational and emotional parts of the brain [66]. This is supported by García [67] who claims that emotions do not function independently, as emotion and cognition get reciprocally affected. Thus, the complexity of education and the importance of emotions in learning are clear, as ascertained by Casassus [68], who suggests that there is no learning or thought outside the emotional threshold. This is why education must consider all the dimensions of human existence [69].

#### 2.4. Lexical Availability

The use of words, or lexical units, reveals the psychosocial framework that can serve as an instrument for the moral and emotional understanding of a group of speakers in a given space and time. A competent speaker, then, has the ability to recognize, learn, retrieve and relate different words in speaking and writing, involving the convergence of elements like vocabulary breadth and depth, and the understanding of the social context that must be taken into account for achieving successful communication [70,71].

The individual's lexical command has been defined as a process of mental structuring. This structure is organized into cognitive categories and constitutes the person's mental lexicon, a place where lexical units are stored, arranged and retrieved when needed [72]. The ability to retrieve lexical units efficiently is related, on the one hand, to the capacity to access an interconnected network of words and linguistic expressions and, on the other hand, to the ability to project those lexical units into the real world by, firstly, selecting the appropriate word in response to an object or circumstance and, secondly, using the appropriate word with the right object and at the right time.

Under the categorization hypothesis, new studies have been undertaken to shed more light on the organization of the mental lexicon. A proposal is the use of lexical availability by means of which researchers determine the semantic relations of words through tests to access the participants' latent lexicon. These studies have led some researchers to adopt psycholinguistic and cognitive perspectives [35,73–75].

The premise of lexical availability is that speakers have at their disposal several words they do not always use in discourse. These are the available words, the ones at our disposal in our mind which we speak or write according to circumstance. These words are elicited by means of word association tests. These tests are known as centers of interest, which stimulate the informant's mental lexicon to produce available words.

### 3. Materials and Methods

#### 3.1. Research Questions and Hypotheses

The challenges posed to teachers by the pandemic, in relation to the virtualization of professional practices, have led to the adoption of various technologies for synchronous communication in teaching, and the design of multimedia material to promote distance learning and student motivation. On the other hand, when considering the importance of ICTs in relation to changing attitudes towards learning, we wondered if the teacher is indeed aware of the emotions that ICTs can bring about and, if they take them into account when choosing ICT tools.

Based on the above, the following research questions were formulated:

1. What ICTs does the teacher use for teaching in the context of a pandemic?
2. How do the ICTs used by teachers differ in the context of a pandemic?
3. What differences are observed in the perception of emotions between groups of teachers when using ICTs in their classes?

Finally, as an application of the importance of using the techniques of lexical availability with emotional in the teaching processes with ICTs, we wondered if this technique allows to show the emotions that Emotional Informatics requires for the adaptability of educational systems and if these same Emotions detected by the lexical availability allow us to generate adjustments in the instructional design in the planning of a class.

These questions led us to test the following hypotheses:

**H1.** *There is a difference in the ICTs used by the different groups of teachers, according to gender, academic background, school type and knowledge area.*

**H2.** *There are differences in the emotions perceived by the different groups of teachers, according to gender, academic background, school type and knowledge area, when using ICTs in the context of a pandemic.*

**H3.** *There are differences in the emotions that the groups perceive and want to modulate in their students using ICTs in the context of a pandemic.*

### 3.2. Procedure

#### 3.2.1. Participants

The sample consisted of 178 teachers from the country's different regions who voluntarily agreed to complete a virtual test of three items associated with the topics of technology and emotions in the context of COVID 19. The participating teachers represented different areas of knowledge such as math, language, sciences, history, arts, music, special education, physical education and primary education.

#### 3.2.2. Ethical Considerations

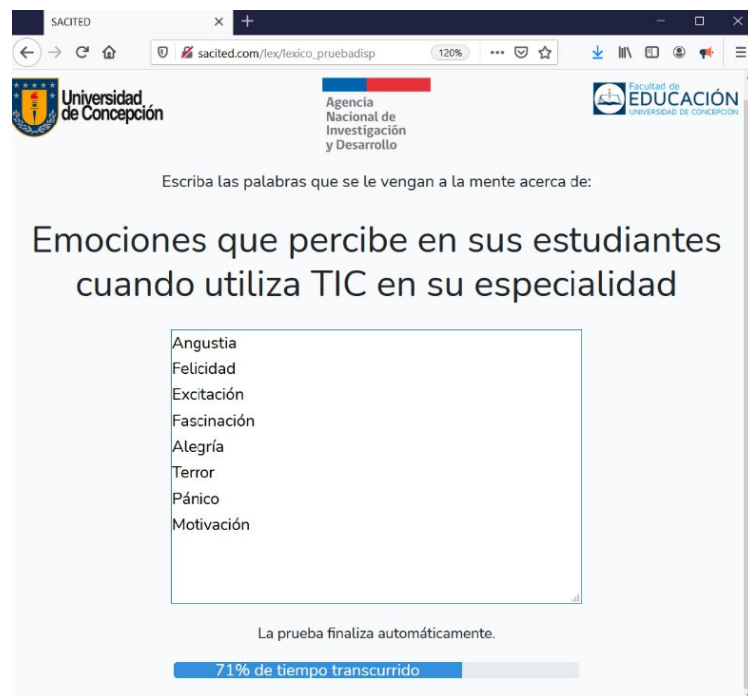
The study was carried out according to confidentiality protocols and duly endorsed by the Ethics Committee of Universidad de Concepción, Chile. Anonymity was maintained and all efforts made not to harm the participating teachers in any way, who voluntarily participated in this study fully aware of the risks and benefits of the study [76]. The required informed consent for the participants was collected right before accessing the virtual test.

#### 3.2.3. Data Collection

The data was collected between November 2020 and January 2021, through the application of a virtual Lexical Availability Test (LAT) consisting of three items related to three centers of interest: (1) ICTs in teachers' specialty, (2) students' emotions perceived by teachers when using ICTs in class and (3) emotions teachers want to modulate in their students during the class to improve involvement with the learning task. The test included a demographic survey where teachers provided information such as years of experience, academic degrees (Bachelor, Master, PhD), school type (public, subsidized, private, other) and the subject matter or knowledge area.

#### Online Lexical Availability Test

This online lexical availability test measured the available lexicon of a group of speakers [77–79] in terms of the three centers of interest indicated previously. To complete the test, the teachers accessed the website <http://www.sacited.cl/encuesta/> (10 January 2021). Upon entering the system, each teacher had to enter their personal information and then sign the informed consent. Then, they proceeded to complete the lexical availability test with all the words that came to mind according to the center of interest (Figure 1).



**Figure 1.** “SACITED system to measure lexical availability”.

For each center of interest, the teachers had two minutes to write all the words that came to mind regarding the topic. Once the data collection was completed, each database was duly revised and corrected to meet the following criteria: each word was capitalized, stress marks were erased, plural forms were made singular and certain words were re-written to better represent the category (for example, applications to app).

### 3.3. Statistical Analysis

The lexical availability test considered the lexical availability index (LAI) as the degree of availability of the word in the group of speakers. It is calculated using the equation below proposed by [80].

$$LAI(P) = \frac{(f_1 + \lambda f_2 + \lambda^2 f_3 + \dots + \lambda(n-1)f_n)}{N} \quad (1)$$

where  $f_i$  is the frequency of the word at position  $i$ , with  $1 < i < n$ . The value of the weighting factor  $\lambda$  is 0.90 and  $n$  is the position of the word.

For the descriptive analysis, three lexical analyzers were used, Dispogen [80], which calculated general indexes and the lexical availability index (LAI) of each word, word frequency and individual indexes. Dispografo [81], which generated Excel databases necessary for the creation of network graphs; and Gephi [82]. This tool generated network graphs and filtered data.

Once the sample was reached, the words which came in text format (.txt) were downloaded and classified by participant and center of interest. Once the databases were cleaned and separated by group, the Cohesion Index (CI), the individual Lexical Availability Index (iLAI) and Word Frequency (WF) were calculated according to the whole sample and according to gender, academic background, school type and knowledge area using the Dispogen program. The network graphs were generated by means of the Gephi software which created interactive images to visualize the weight of the nodes and the strength of the links between nodes.

For the group comparative analysis, gender, academic background, school type and knowledge area were used. For each of these groups, the individual LAI and word frequency (the production of words per participant) were examined for normality and equality variance (Shapiro-Wilk and Levene). For the gender group the Student *t*-test was used, and for the other groups (academic background, school type and knowledge area) ANOVA and Kruskal Wallis were used. Then, the post hoc test specified the statistically significant differences among the analyzed groups.

#### 4. Results

The results will be presented on the basis of the theoretical underpinnings that were described in the theoretical framework of this study, namely, technologies and emotions in education, studied by means of the lexical availability technique.

In this section, the results from the different analyses are shown using the lexical statistics, which comprised the following indexes and concepts [83,84]:

WA: word average; DW: different words; CI: cohesion index (different words and word average ratio); LAI: lexical availability index per word (the higher the LAI, the more latent the word is in the participants' memory); iLAI: individual lexical availability index. This allowed researchers to determine how close the lexicon of a participant was with respect to the group.

Graph theory allowed these researchers to study the semantic networks that emerged from the latent lexicon. The associated techniques allowed for the observation of each node with a size according to the frequency with which the word was said and the links between the nodes, according to the frequency with which a certain sequence of words was said.

##### 4.1. H1: There is a Difference between the ICTs Used by the Different Groups of Teachers, According to Gender, Academic Background, School Type and Knowledge Area

For this hypothesis, descriptive analyses were carried out in a general way that involved the first center of interest and then the different groups that participated in the study. The statistically significant results per group are shown below: gender and knowledge area. The groups of academic background and school type did not present statistically significant results.

##### 4.1.1. General Analysis

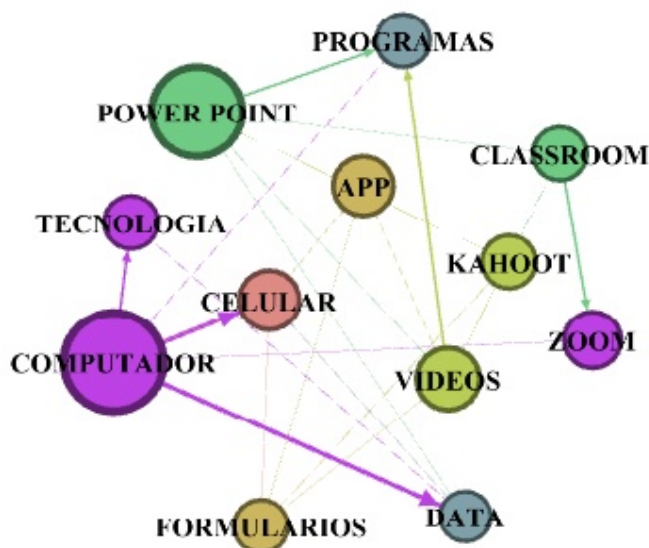
Table 1 shows the LAI in descending order of the first 10 words in the center of interest 1, allowing us to observe the words that teachers have more available when they face the use of ICTs in the class.

**Table 1.** LAI of the first 10 words in the center of interest "ICTs in teachers' specialty".

Center 1	
Word Type	LAI
COMPUTER	0.137
POWERPOINT	0.079
ZOOM	0.050
TECNOLOGY	0.049
CELULAR PHONE	0.043
PROGRAMS	0.043
VIDEOS	0.042
DATA	0.040
PLATAFORMS	0.039
KAHOOT	0.039

For the first center of interest that there were words related to general use technologies and new technologies that are currently used in the context of virtual classes due to the pandemic, such as ZOOM, CELLULAR or KAHOOT.

Figure 2 shows the graph generated by the words of the teachers in the first center of interest.



**Figure 2.** Network graph of the center of interest “ICTs in teachers’ specialty.”

The generated graph presented links with greater strength between the words COMPUTER—DATA, COMPUTER—CELLULAR, POWER POINT—PROGRAMS and CLASSROOM—ZOOM. The latter related to technologies that are commonly used in remote classes, as well as words such as APP, VIDEOS and FORMS.

#### 4.1.2. Analysis according to Gender

Table 2 shows the general indexes of the lexical availability test with a sample formed by 63 male and 115 female participants.

**Table 2.** Male and female participants’ general indexes.

	Center 1		Center 2		Center 3	
	Male	Female	Male	Female	Male	Female
Tokens	189	548	414	762	429	791
Types	129	301	172	218	158	228
Word average	2.95	4.77	6.47	6.63	6.7	6.9
Cohesion index	0.023	0.016	0.038	0.031	0.042	0.03

In all centers of interest, female participants produced more tokens (total number of words) and types (words used only once) than their male counterparts, having a higher word average. The male participants, however, showed a higher cohesion index (CI) than the female group, even though it was low for both gender groups. This indicates that men have a greater level of awareness of their clusters than women, although the difference is modest.

Table 3 shows the 5 most available words (LAI) for male and female participants for the center of interest 1.



**Table 3.** LAI according to gender for center of interest 1.

Center 1			
Male		Female	
Lexical item	LAI	Lexical Item	LAI
COMPUTER	0.1335	COMPUTER	0.1387
POWERPOINT	0.0625	POWERPOINT	0.0855
EXCEL	0.0609	ZOOM	0.0625
DATA	0.0463	TECHNOLOGY	0.0611
CELL PHONE	0.0411	LEARNING	0.0581

The words with the highest LAI for center of interest 1, for male and female participants, are COMPUTER and POWERPOINT. The words that follow, in the case of the male participants, were associated with tools and digital devices; in the case of the female participants, the words that followed were associated with digital applications and tools used in online education like MEET or ZOOM. For the center of interest 2 and 3, the reported words were similar in both groups.

Figure 3 shows male and female participants network graphs for center of interest 1.

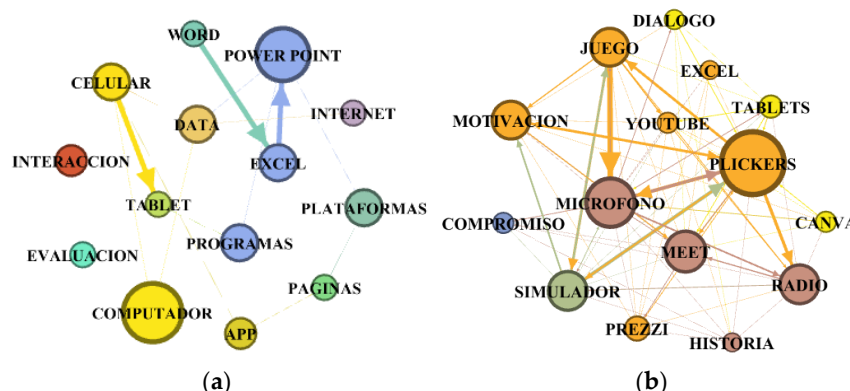
**Figure 3.** Center of interest 1 network graphs, “ICTs in teachers’ specialty”: (a) Male participants network graph (b) Female participants network graph.

Figure 2 shows that the graph of the female participants had greater connections between the nodes than the male participants’ graph. Specifically, the words that the female participants used regarding ICTs were more closely related to each other, which could mean that their latent vocabulary was more homogeneous. Among the most used and related words in the female participants, we found technologies with greater relevance to the educational context experienced in a pandemic. There were also nodes attributed to emotions, something that was not present in the graph of their male counterparts. This relationship between ICTs and emotions shown by the female participants seems relevant, as it may lead this group to better relate emotions to technology use, also presenting latent words related to more didactic digital tools. The words that the male participants reported in relation to ICTs, however, showed a more common use.

Previous analyses were performed to determine if the data were normally distributed (Shapiro Wills) and if they had similar variances (Levene). For the frequency of words per individual of men and women, the data were not normally distributed or with similar variances in any of the centers of interest, so the Mann Whitney U test was used, whose hypotheses were:  $H_0$  = There is no significant difference between the frequency of words per individual of men and women;  $H_1$  = There is a significant difference between the frequency of words per individual of men and women, where the frequency of men is lower than the frequency of women. The results are shown in Table 4.

**Table 4.** U of Mann Whitney comparison of word frequency for men and women.

Center of Interest	<i>w</i>	<i>p</i>	Rank-Biserial Correlation
Center 1	3116.500	<0.05	−0.153

Note. For all tests, the specific alternative hypothesis is that the MALE group is lower than the FEMALE group.

The null hypothesis was rejected, and the alternative hypothesis was accepted, that is to say: men showed a lower production of words than women in terms of ICTs in their specialty. This could be showing that in the context of a pandemic, women have a higher and more varied latent lexicon than that of men, as observed in Figure 3.

#### 4.1.3. Analysis according to Knowledge Area

The teachers were grouped according to their academic area: Humanities (Language, Philosophy, History) with 13 teachers, Sciences (Mathematics, Sciences) with 113 teachers and Multiple (Primary Education, Physical Education, Special Education) with 52 teachers.

The ANOVA test was used for both the iLAI and word frequency per individual according to knowledge area. Only one difference was found for the first center of interest according to word frequency per individual ( $p < 0.001$ ). Consequently, a Post Hoc test was used, the result of which is found in Table 5.

**Table 5.** Post Hoc Test for comparison of knowledge areas.

		Mean Difference	SE	<i>t</i>	<i>p</i> Tukey
SCIENCES	HUMANITIES	−5.154	1.456	−3.540	<0.001
	MULTIPLE	−6.000	0.832	−7.209	<0.001
HUMANITIES	MULTIPLE	−0.846	1.542	−0.549	0.847

Significant differences were observed between the groups of Sciences, Humanities and Multiple teachers, where the frequency of words per individual proved to be higher in Humanities and Multiple teachers. This is due to the fact that teachers of scientific areas tend to use more specific ICTs to their field.

#### 4.2. H2: There are Differences in the Emotions Perceived by the Different Groups of Teachers, According to Gender, Academic Background, School Type and Knowledge Area, When Using ICTs in the Context of a Pandemic

For this hypothesis, descriptive analyses were carried out in a general way that involved the second center of interest and then the different groups that participated in the study. Statistically significant results were found in the gender and academic background groups. For the knowledge area and school type groups, no statistically significant results were found.

##### 4.2.1. General Analysis

Table 6 shows the LAI in descending order, of the first 10 words in center of interest 2. Allowing us to observe the words that teachers had more available in relation to the emotions they perceive in their students when they use ICTs.

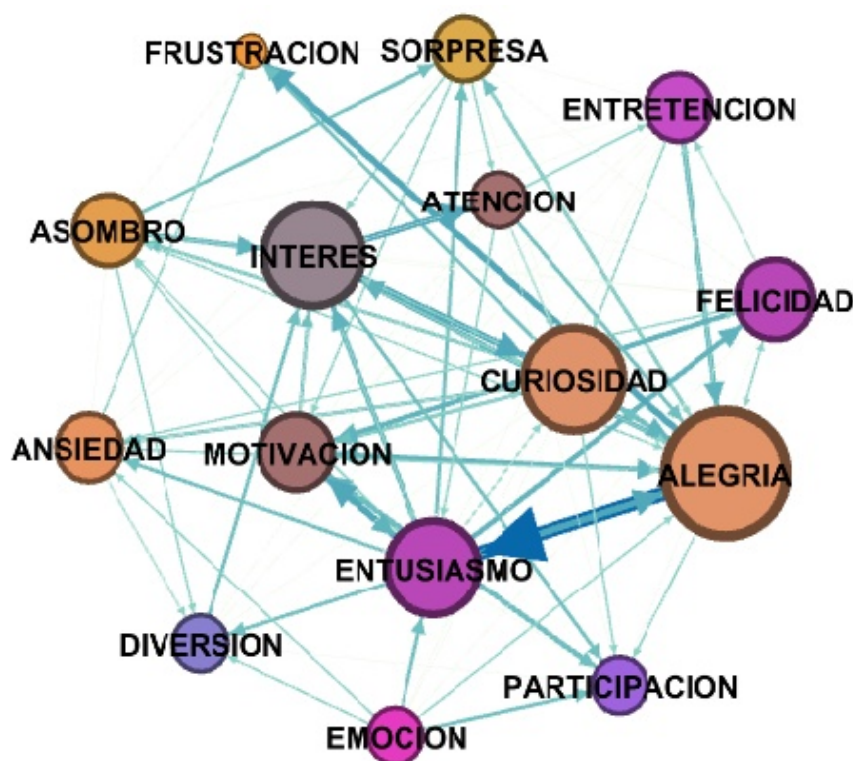
**Table 6.** LAI of the first 10 words in the center of interest “emotions perceived by teachers in their students when using ICTs in class”.

Center 2	
Word Type	LAI
JOY	0.472
ENTHUSIASM	0.263

INTEREST	0.249
CURIOSITY	0.221
MOTIVATION	0.219
AWE	0.179
HAPPINESS	0.172
SURPRISE	0.154
EMOTION	0.143
ANXIETY	0.138

In the second center of interest, words of both a positive and negative nature were identified, such as ANXIETY, which could be since teachers have enough emotional intelligence to detect the emotions of their students in the context of online classes. However, the number of negative emotions detected was much lower than positive emotions, which is either because students actually have positive emotions when it comes to remote classes, or teachers have not been able to detect students' real emotions due to the modality of classes.

Figure 4 shows the network graph of the teachers in the second center of interest.



**Figure 4.** Network graph of the center of interest 2 “emotions perceived by teachers in their students when using ICTs in class”.

The second center of interest shows the nodes with the strongest links among the words JOY—ENTHUSIASM. These connections are commonly mentioned in the LAI by the teachers.

#### 4.2.2. Analysis by Gender

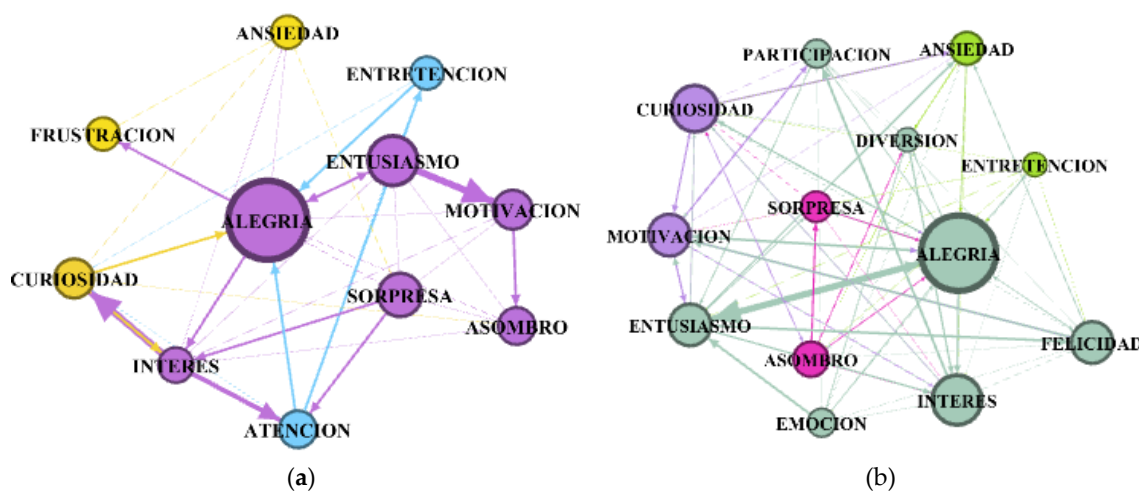
Table 7 shows the first 5 words between men and women for the second center of interest.

**Table 7.** LAI according to gender in the second center of interest.

Center 2			
Male		Female	
Lexical Item	LAI	Lexical Item	LAI
JOY	0.3226	JOY	0.5427
ENTHUSIASM	0.2207	ENTHUSIASM	0.2801
INTEREST	0.205	INTEREST	0.2691
MOTIVATION	0.2012	MOTIVATION	0.2399
CURIOSITY	0.1768	CURIOSITY	0.2231

The first two words with the highest LAI for both men and women were JOY and ENTHUSIASM. The words that followed were the same, although for men the word MOTIVATION had a higher LAI than CURIOSITY, which was the opposite in the LAI of women.

Figure 5 shows the network graphs by men and women in the center of interest 2 “emotions perceived by teachers in their students when using ICTs in class”.

**Figure 5.** Center of interest 2 network graphs: (a) Men (b) women.

In Figure 5 again, the graph of women presents a greater interconnection within its network than that of men. Both graphs have similar words, however, the female vocabulary type represents an educational environment with active students, where mostly positive emotions are perceived. On the other hand, the type of vocabulary of men is similar to that of women, with the difference that they perceive emotions related to the students' attention instead of participation.

In the case of the iLAI of men and women, the data was found to have normal distribution with similar variances for all the centers of interest, then a Student *t* test was used, whose hypotheses were: H0 = There is no significant difference between the iLAI of men and women; H1 = There is a significant difference between the iLAI of men and women, where the iLAI of men was lower than the iLAI of women. These results are found in Table 8.

**Table 8.** Student *t* test of men and women LAI.

Center of Interest	<i>t</i>	df	<i>p</i>
Center 2	−3.436	177	<0.001

Note. For all tests, the specific alternative hypothesis is that the MALE group is lower than the FEMALE group.

For the second center of interest, the null hypothesis was rejected, and the alternative hypothesis was accepted, so the iLAI of women was higher than that of men. It can be deduced that the lexicon among women is similar within their group. This is related to what is observed in Figure 5, which showed a greater number of connections between the words of women.

#### 4.2.3. Analysis According to Academic Background

The academic background sample was organized into years of experience and academic degrees. The teaching career assessment system used in Chile was taken as reference for the categories and their progression, with only minor modifications. To those with 8 years of experience, 2 points were given to those in possession of a Diploma, 4 for a master's and 8 for a doctorate. Eventually, the academic background sample was arranged as follows: Initial (0–3 years) with 31 teachers; Competent (4–7 years) with 30 teachers; Advanced (8–11 years) with 39 teachers; Expert I (12–15 years) with 26 teachers; and Expert II (16 + years) with 52 teachers.

The variance test showed a  $p$  value of  $< 0.001$ , showing no similar variance for the data. Thus, the Kruskal-Wallis test was used for the individual LAI, as well as for the individual word frequency in each group for academic history. A significant difference was found only in the second center of interest according to individual word frequency with a  $p$  value of  $< 0.05$ ; consequently, the Games-Howell was applied, as shown in Table 9.

**Table 9.** Games-Howell Post Hoc Test for Academic background comparison.

Comparison	Mean Difference	SE	$t$	df	$p$ Tukey
ADVANCED—EXPERT I	−0.681	0.804	−0.846	50.396	0.915
ADVANCED—EXPERT II	−0.478	0.647	−0.739	67.831	0.947
ADVANCED—INITIAL	−3.321	1.281	−2.593	32.973	0.095
ADVANCED—COMPETENT	−1.484	0.597	−2.488	71.319	0.105
EXPERT I—EXPERT II	0.203	0.822	0.247	54.631	0.999
EXPERT I—INITIAL	−2.641	1.378	−1.917	41.168	0.325
EXPERT I—COMPETENT	−0.804	0.782	−1.027	49.756	0.842
EXPERT II—COMPETENT	−2.843	1.292	−2.200	34.109	0.204
EXPERT II—COMPETENT	−1.006	0.620	−1.623	81.058	0.487
INITIAL—COMPETENT	1.837	1.268	1.449	31.904	0.602

According to these findings, although there were differences, these were not significant for any of the academic background groups in terms of the frequency of words per individual. This similarity between the groups can be explained by the fact that the study considered specific technologies in the educational area, of which teachers with varying expertise had similar knowledge, which did not necessarily mean they knew how to handle or use them in a pedagogical context. As for centers of interest 2 and 3, they were also similar between the studied groups, which may mean that even though teachers were aware of emotions, they did not actively exercise their emotional intelligence.

#### 4.3. H3: There Are Differences in the Emotions that the Groups Perceive and Want to Modulate in Their Students Using ICTs in the Context of a Pandemic

For this hypothesis, descriptive analyses were carried out in a general way that involved the third center of interest and then the different groups that participated in the study. In this hypothesis, only the analysis according to gender had statistically significant results.

#### 4.3.1. General Analysis

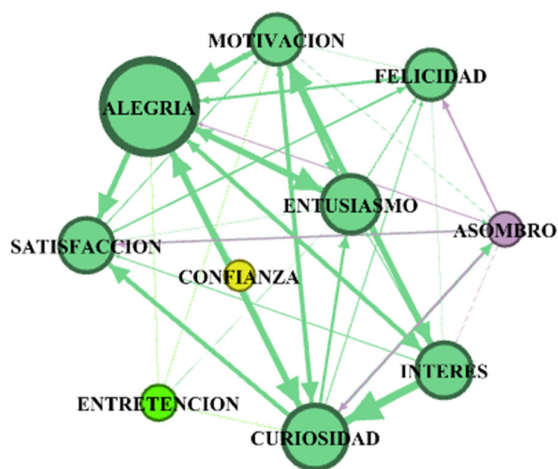
Table 10 shows the first 10 words with the highest LAI among teachers for the third center of interest.

**Table 10.** LAI of the first 10 words in the center of interest “emotions teachers perceive and want to modulate in the student during his classes”.

Center 3	
Word Type	LAI
JOY	0.429
INTEREST	0.369
CURIOSITY	0.340
MOTIVATION	0.256
ENTHUSIAM	0.208
HAPPINESS	0.149
SATISFACTION	0.134
AWE	0.096
SURPRISE	0.078
FUN	0.076

Only positive emotions can be observed in the teachers’ mental lexicon, which coincides with this center of interest that elicited emotions that teachers would want their students to experience when taking online classes.

Figure 6 shows the network graph for teachers in the third center of interest.



**Figure 6.** Network graph generated for the center of interest “emotions teachers want to modulate in the student during his classes”.

In the third center of interest, the nodes with the strongest link were found between ENTHUSIASM—MOTIVATION, JOY and CURIOSITY.

#### 4.3.2. Analysis by Gender

Table 11 shows the first 5 words between men and women for the third center of interest.

**Table 11.** LAI according to gender in the third center of interest.

Center 3			
Male		Female	
Lexical Item	LAI	Lexical Item	LAI
JOY	0.3979	JOY	0.4408
INTEREST	0.3257	INTEREST	0.3901
MOTIVATION	0.2974	CURIOSITY	0.3595
ENTHUSIASM	0.2032	MOTIVATION	0.2821
AWE	0.2031	ENTHUSIASM	0.2081

For both men and women, the words with the highest LAI were JOY and ENTHUSIASM. For this center of interest, we found words that were not shared between the groups. In the case of men, the word AWE was mentioned, while among women the word CURIOSITY was mentioned.

Figure 7 shows the NETWORK graphs for men and women in the center of interest “emotions teachers want to modulate in the student during his classes”.

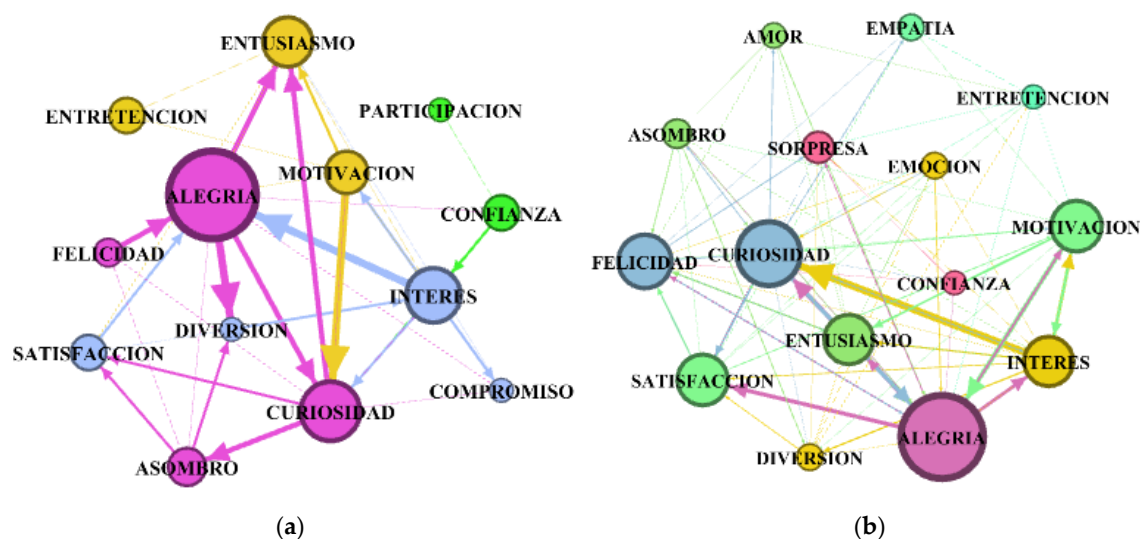
**Figure 7.** Network graphs for center of interest 3: (a) network graph of men (b) network graph of women.

Figure 7 shows that although the men's graph had stronger links between the nodes, the women's graph continued to present a greater interconnection. Even though the vocabulary was similar in both, there were interesting differences to note. The words of men were repeated in that of women, with the exception of PARTICIPATION and COMMITMENT, which indicates that teachers seek to promote these actions, not emotions, in their students when they use ICTs. On the other hand, the words of the women that were not contained in the men graph are LOVE, EMPATHY, EMOTION, SURPRISE and AWE, which leads to suppose that women are concerned with modulating emotions in students that benefit them when they use ICTs in their classes.

For the iLAI of men and women, a Student *t* test was used, whose hypotheses were: H0 = There is no significant difference between the iLAI of men and women; H1 = There is a significant difference between the iLAI of men and women, where the iLAI of men is lower than the that of women. These results are shown in Table 12.

**Table 12.** Comparison of Student t-test on male and female LAI.

Center of interest	<i>t</i>	df	<i>p</i>
Center 3	−2.637	176	<0.005

Note. For all tests, the specific alternative hypothesis is that the MALE group is lower than the FEMALE group.

As in the second center of interest, the null hypothesis was rejected and the alternative hypothesis was accepted, which means that the iLAI of women is higher than that of men in the centers of interest related to emotions.

## 5. Discussion

Considering the previous analyses, in this section we focused on contrasting the hypotheses under study.

The hypotheses that we hoped to test are related to the differences that could exist in the ICTs lexicon and the emotions perceived by the teacher and those they would want to modulate in their students according to the different groups of participants.

The results have shown differences between teachers in the context of a pandemic, presenting a scarce but diverse and heterogeneous ICT vocabulary. This coincides with the studies by [17,85–89], where the vocabulary about technological resources was low. This can be explained by the fact that the sample consisted of teachers from different areas, and each area had ICTs determined by specialty, which shows how segmented education can be in Chile.

For the second and third centers of interest, mostly positive emotions were observed. This is the first time that a lexical availability study that directly involves emotions has been done in Chile, so no studies have been found to compare the results with.

### 5.1. Gender

No significant difference was found between the individual LAI of male and female participants in the use of ICTs in their specialty. However, there was a significant difference in the production of words between both groups, the female participants showed more ICTs vocabulary breadth than their male counterparts.

Correspondingly, there was a difference in word frequency for each group. On the one hand, the male participants used lexical items that are related to software and tools that can be considered common like COMPUTER, CELL PHONE, POWERPOINT, WORD and EXCEL. On the other hand, the female group used words that are more commonly associated with online teaching, especially in this pandemic context, like ZOOM, MEET, CLASSROOM, KAHOOT, QUIZZ or PLIKERS. Despite the fact that in both groups the cohesion index is low, the male group showed a higher level of lexical coincidence than their female counterparts.

No significant difference was found in the production of words for the second and third centers of interest. However, there was a significant difference in the individual LAI of male and female participants, that is to say, the female teachers displayed more similar vocabulary to the general one than the male participants, for both the emotions they intended to modulate and the ones they perceived in their students when using ICTs.

Up until now, several studies on lexical availability [17,85–89] had failed to report findings such as these ones, where it was possible to determine differences between the lexical availability index and word frequency per individual by gender.

### 5.2. Academic Background

No significant differences were found between the individual LAI and word frequency in those participants belonging to the initial, competent, advanced, expert I and expert II categories for the first center of interest. This finding contradicts the ones found by [17,85,87], where they claimed that older participants had lower lexical competence



than that of the younger ones. However, these studies only included participants' age and centers of interest dealing with technological vocabulary not related to education. On the other hand, there were no significant differences according to academic history in the second and third centers of interest.

A significant difference was found between type and token that were frequent to both groups. The more the academic history developed, the greater the nodes and the stronger the links in all centers of interest.

### 5.3. School Type

Despite the fact that no significant differences were found in the individual LAI and word frequency of the participant groups in any of the school types, it was possible to observe a difference between the type and token frequency for both groups. This is consistent with the studies by [90–92] who found no differences in the LAI by type of school but did so in the type of words used. The private school group showed the greater mean between the individual LAI and word frequency, followed by the other institution category. The lowest mean of words was shown by the participants working in subsidized schools. It was also possible to find different lexical competencies between groups, participants from state schools used words related to common ICTs use like COMPUTER, DATA, POWERPOINT or CELL PHONE. In the private and subsidized groups, words related to digital tools and online classes like CLASSROOM, ZOOM and MEET were found. Interestingly, and even though the category of other institutions showed a network graph with multiple nodes, it is the one that presented the highest cohesion index of the entire study.

### 5.4. Knowledge Area

Significant differences were found for the first center of interest in relation to the production of words among the Sciences, Humanities and Multiple groups. The Sciences teachers produced fewer words than the Humanities and Multiple groups. These results are consistent with the study by [93] who found differences in academic skills between humanities and science. The difference in the present study can be explained by the fact that teachers of the scientific area concentrate their use in fewer ICTs tools than those of other areas; they also included less ICTs vocabulary like MEET, CLASSROOM or POWERPOINT, unlike the other groups who did report the use of these words.

## 6. Conclusions

The results of the present study allowed us to address the research questions and contrast the associated hypotheses that operationalize the theoretical postulates that support the present study.

Through the lexical availability technique, it was possible to access information on emotions and technologies in education used in times of pandemic by teachers in the Chilean school system. The main conclusions of this study are:

- Teachers, in the context of a pandemic, have a list of words in their mental lexicon associated with technologies commonly used in distance education. This list has various applications, on the one hand, it allows generating improvement or initial training plans that incorporate relevant ICTs in certain disciplinary areas, which are generally not taken into account by teachers; and, on the other hand, they allow generating instructional designs and activities that consider the technologies present in the majority of teachers' mental lexicon in the studied context.
- Teachers perceive positive and negative emotions when they use ICTs in their classes. The emotions they intend to modulate in their students are positive in nature. This finding is possible thanks to the lexical availability test, which reveals the most latent emotions lexicon of teachers when using ICTs in a given time and context. This emotions lexicon can make it possible to establish an improvement or initial training plan regard-

ing the integration of ICTs in the classroom, considering that different types of technologies can generate different emotions in students. It also allows generating instructional designs and activities that consider the emotions associated with certain technologies.

- The significant differences found in the production of words between men and women (ICTs and emotions) or between science teachers and other areas, allows us to pay attention to the importance of considering the differences between the various groups in the initial teacher training and the continuing professional development.

On the other hand, accessing the knowledge and organization of the mental lexicon has been one of the major challenges that several multidisciplinary research groups have tried to address. This study proposed the use of a methodology traditionally employed in latent lexical retrieval of a group of speakers around one or more centers of interest. The possibility of personalizing the teaching to the emotions of each one, is what Affective Informatics has been looking for, using different resources for this task. In this study, lexical availability has been used to know more about the emotional lexicon of different groups and the lexicon available individually for each participant, which is an essential input to generate the adaptability of an intelligent system. On the other hand, knowing the differences in the latent lexicon of each group allows an instructional design to be adapted to the emotional or knowledge needs of each group.

The previous techniques, statistical lexicon and lexical graphs, make it possible to obtain not only the most latent words, but also the strongest lexical-semantic relationships in a group of subjects. This allows us to predict how a subject with a similar profile structures his knowledge or emotions [94,95]. This is how it is possible to adapt the system to the needs of each subject or group.

On a theoretical level, the contribution of this study lies in broadening the spectrum of lexicon associated with traditional centers of interest (transport and parts of the body), which allow for the elicitation of words of common use, to using complex centers of interest. The reports of these new centers imply access to the organization of the mental lexicon in relation to the perceptions that teachers have about the emotions of their students, visualizing a lexicon that elicits words that could not be elicited with traditional tests, but also adding the condition of being used in a specific context (online classes).

An important implication of this study is based on the fact that it does not only manage to obtain the most available words around the technologies used during a virtual class, but also deepens the scope of lexical availability by including the teachers' perception of emotions they find in their students during online classes and the emotions they want to modulate during classes as a center of interest. On the other hand, presenting the available lexis in the form of network graphs allows the reader to visualize how different groups organize their lexical relations, emotions and knowledge in relation to a center of interest.

#### *Study Limitation and Projections*

The study used the lexical availability technique which determines the lexicon or vocabulary that is latent among the respondents, but it does not measure skills. It is required to measure mastery in ICTs use. On the other hand, emotions are measured as a perception that teachers have about their students.

The possibility of adapting a teaching system (software) to the needs of a subject requires having contextual and temporal knowledge of the group, which is unfeasible by traditional methods. Techniques in real time are required in each context, being text mining in social networks or directly inside the classroom a possibility for using means such as mobile technologies or voice assistants.

As a projection, it is suggested to continue investigating emotions in a contextual and temporal way, considering the adjustment of an instructional design to emotions or the adaptability of intelligent tutorial systems to the emotional characteristics of the students. Without failing to consider the importance of emotions in teacher improvement and how they are related to ICTs and the curricular proposal that can be implemented with them.

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