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Article

Academic Lexicon Development in an EMI Context: A Study of Pre-Service English Teachers' Lexical Availability

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Abstract
Lexical availability assessment has been widely used in vocabulary research. This data collection technique uses lexical statistics based on controlled association tests that activate the production of lexical items as a reaction to a stimulus, thus evidencing the productive lexical knowledge of the speakers. Lexical availability also allows the exploration of the organization of the mental lexicon through the generation of semantic networks that show the underlying relationships between the words recalled. With this objective in mind, a lexical availability test composed of 2 centers of interest (i.e., methods and approaches in L2 learning and lesson planning) was applied to a sample of 350 pre-service teachers in an English Medium Instruction (EMI) context to explore their academic vocabulary knowledge and mental lexicons. The results show that as the years of study of the subject in the sample increase, the average number of words they can recall and the degree of coincidence in the responses also increase. In addition, greater specificity in the specialized lexicon is observed as the students move forward through the curriculum. From a pedagogical point of view, lexical availability and semantic networks make it possible to monitor students' lexical acquisition process and to determine remedial measures when deemed necessary. The implications of these findings highlight the significance of monitoring the progression of academic vocabulary and specialized lexicon in EMI contexts. This monitoring enables the adaptation of teaching approaches and lesson plans to facilitate students' gradual improvement in these areas, thereby enhancing their language skills and academic success.

Keywords
Lexical availability, technical vocabulary, English Medium Instruction, pre-service teachers

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1. Introduction

One of the central questions of contemporary psycholinguistics is the study of the acquisition of lexical knowledge and how it is organized in a speaker's memory for immediate access and use, and this is where the concept of the mental lexicon becomes relevant. According to Aitchison (2003), the mental lexicon can be defined as the store of mental representations associated with words, which holds both the semantic and syntactic information, and the lexical units associated to them.

The relationship between words is grounded in the mental lexicon. Consequently, the study of specialized words is an important issue to address within the area of lexical availability. In this regard, some studies have been carried out to delve into the academic lexicon. These studies have been able to estimate the available lexicon and establish a relationship between vocabulary increase and years of study (Roghani & Milton, 2017; Quintanilla & Salcedo, 2019, Milton & Alexiou, 2020; Quintanilla & Kloss, 2023).

It should be noted that lexical availability is seen as a data collection task and as a concept. According to this view, Jiménez-Catalán (2023) states that:

> as a concept it refers to the cognitive processes involved in the search, retrieval, and recall of words from the mental lexicon. As a task, it includes semantic categories such as food and drink, clothes, school or animals, which are used as prompts to elicit the words stored in the mental lexicon of language learners (p. 50).

According to the above, this data collection technique allows access to the lexical knowledge that is part of the mental lexicon of those who are confronted with a lexical availability survey. In the EMI context, where English serves as the medium for acquiring disciplinary knowledge, lexical learning becomes even more important since a good command of vocabulary is essential to comprehend and generate knowledge, as emphasized by Bonorino and Cuñarro (2006). In this context, exploring lexical knowledge through lexical availability and semantic networks is relevant to language teaching and teacher training in an EMI environment.

In conclusion, lexical availability could help us understand the lexical acquisition process of pre-service English teachers during their training since it reveals the words that are more available to them when confronted with a certain center of interest. Thus, it would reveal not only their lexical knowledge, but also their disciplinary knowledge and the interconnectedness among these words. Consequently, this information contributes to the task of determining lexical growth and changes that take place in students' mental lexicons because of training processes and curricular development.

In the context of pre-service teacher training, their understanding of what language is, and how it is learned becomes particularly relevant, as well as their knowledge regarding the design of sequences of activities intended to achieve the learning outcomes. Thus, the present study aims to explore the knowledge of academic vocabulary and mental lexicon in two centers of interest, methods and approaches in language teaching and lesson planning, in a sample of 350 pre-service teachers of English as a foreign language. The questions that guided this study are:

1. What are EFL pre-service teachers' available lexicon in the centers of interest "methods and approaches in L2 learning" and "lesson planning"?
2. How are EFL pre-service teachers lexical-semantic networks constructed?

2. Background

This section reviews relevant literature in these areas: lexical availability, the specialized and/or specific lexicon in the pedagogical field of second language (L2) teaching.

2.1 Lexical availability

Studies of lexical availability originated in France in the 1950s led by a group of French researchers working on the "Français élémentaire" project (Gougenheim, Michéa, Rivenc, & Sauvageot, 1956). The main objective of the project was to develop a "base language" that included essential grammar and vocabulary for teaching French to immigrants and inhabitants of former French colonies.

Initially, they focused on creating a frequency-based lexicon, on the premise that words used more frequently should be taught first. However, they soon realized that this selection criterion was not appropriate, as essential communication words did not always appear in frequency lists or were positioned very low on them. As a result of these studies on lexical frequency, they obtained a list of words in decreasing order that included: grammatical words, verbs, adjectives, and some nouns.

Following these results, the researchers decided to shift their focus and concentrate on the presence of words in discourse, thus establishing a distinction between frequent lexicon and available lexicon. The frequent lexicon encompassed words that appeared consistently and independently of the subject being discussed, that is, athematic words. Conversely, the available lexicon consisted of words that only surfaced when addressing a specific topic or theme.

Gougenheim (1967) pointed out that available or latent words are present in speakers' minds, but only used when the communicative context requires them. Similarly, Michéa (1953) asserted that:

> an available word is one that, though not particularly frequent, is always ready to be used and immediately and naturally comes to mind when needed. It is a word that, forming part of usual associations of ideas, exists potentially in the speaker and comes into play at the appropriate moment. (p. 340).

As a result of Michéa's (1953) work, researchers started using associative tests focused on specific themes. In these tests, participants were prompted to provide or write down words associated with a particular topic or area of interest. These associative tests are a crucial component of lexical availability studies, aimed at identifying the words naturally associated with specific topics. This approach aligns with the goal of creating the *base language* as envisioned by Gougenheim et al. (1956). Using these tests, speakers spontaneously speak out or write down words related to a given topic, which enables researchers to understand how words are connected to concepts in speakers' minds and to determine which words are more likely to be used in particular situations. This becomes valuable information for language teaching and contextualized communication as, understanding which words are readily available to learners, teachers can tailor instruction to focus on expanding vocabulary in areas where learners may be lacking. Additionally, understanding learners' lexical availability can help teachers identify common lexical errors and areas for improvement in lexis.

2.2. Specialized language and technolect

When we discuss the theoretical construction of specialized language and technolect, we encounter various terms used to describe this phenomenon. These terms include *specialization, special language, technical language, specific-purpose language,* and *technolect*. For this research, we use the term *technolect* because we consider it a linguistic register formed through the expansion of knowledge in a given field of human activity. A technolect is used by speakers who master the subject matter or have a certain knowledge of it (Haensch et al., 1982).

Technolect constitutes a subsystem of the general language accessed by a specialized linguistic community. This term refers to a code used by members of a specific community to communicate in a work and social sphere (Dorta, 2015). In this regard, Pérez (2008) argues that the technolect is typical of professional groups that handle a certain level of specialization. Likewise, Rumbos and Valles (2008)

state that *technolect* corresponds to a variant of the language that has specific purposes, and that allows a technical type of communication among experts. Therefore, he defines it as "specific speech of a community of professionals, that is, how these groups make use of the language in different contexts and that is little understandable or incomprehensible to the rest of the users of that language" (Rumbos & Valles, 2008, p.153). Finally, the term *technolect* is defined according to Cordero (2009, p. 78), who conducted a review on specialized lexicon versus common lexicon, as "a set of linguistic resources common to a group of speakers related to a profession or subject". According to these definitions, *technolect* refers to a type of lexicon that is part of a larger system, but which would be used by a restricted group of speakers who share this lexicon for reasons of technical or professional training.

2.3 Studies of lexical availability in specific or specialized lexicon

A speaker's vocabulary is only updated when very specific information needs to be communicated (López, 1999). Urzúa et al. (2006) emphasized the need to study what happens with the available lexicon of speakers who are active in a specialized context and who are part of a speech community that uses a specialized lexicon to interact effectively within that community. This aligns with the aim of identifying the words that a student must acquire by the end of their professional career to be able to interact in that community.

Studies in this specialized community or technolect have focused on the media, mathematics, legal sciences, and physical therapy. In the area of the media, Guerra and Gómez (2003) and Gómez and Guerra (2004) aimed to identify the lexicon linked to the media field (centers of interest: press, radio, and television), with the pedagogical purpose of teaching specialized Spanish lexicon to foreign students of communication. The results show that communication students exhibit greater lexical richness compared to other studied groups, such as law students. Additionally, the lexical associations made by students of audiovisual communication and journalism are more focused on the social aspect of communication rather than its technical aspect.

In the area of mathematics, the studies by Urzúa et al. (2006), Salcedo and Del Valle (2013), and Ferreira et al. (2014) aimed to quantify and describe the available lexicon of high school students in different centers of interest or cue words related to mathematics such as algebra, geometry, and statistics, among others. The results of these investigations show that there is a growth of students' available lexicon as they increase their years of study, that teachers always obtain a higher average of answers than students in all the centers of interest, and that all the groups surveyed share a large part of their available lexicon.

In the legal area, the work of Medina (2009) focused on the lexical availability of law students and practicing lawyers in four areas of interest: civil law, criminal law, procedural law, and constitutional law. The results show that as students advance in their academic training, their answers become more relevant when compared with those of specialists.

Finally, in physiotherapy, the study by Navarro (2009) had as its main objective to uncover the lexicon related to physiotherapy with a pedagogical purpose and produce the publication of a *Dictionary of Specific Available Lexicon* in the area of Physiotherapy. The sample consisted of first, second, and third-year students of the Diploma in Physiotherapy. The author suggests that this material would allow remedial actions to be taken in the face of possible deficiencies in the teaching-learning process, since it provides information regarding students' lexical domain and, consequently, their conceptualization of reality.

In general, research on lexical availability in specialized areas has focused on studying the evolution of the specialized lexicon as the subjects' years of study increase at both the school and university levels. In addition, in some cases, the lexicon of students is contrasted with experts, either teachers or practicing professionals. The results of these studies show a growth in the available lexicon of the students as their years of study increase (Urzúa et al., 2006), and it is also observed that the subjects

present a more technical or specialized lexicon (Gómez & Guerra, 2004) and that the answers become more relevant when compared with those given by specialists (Medina, 2009). In the area of specialized lexical availability, some studies have also been developed to determine the lexicon of future teachers of Spanish as a foreign language (Pedroni, 2015), English as a foreign language (López, 2017) and in early childhood and primary education (Herranz, 2018). Although these investigations focus on groups of *experts*, the only one that seeks to obtain information regarding specialized lexicon or technolect is the one conducted by López (2017), as it focused on lexical availability in the Linguistics technolect in 40 English pedagogy students in their 3rd and 7th semesters. The results show that there is a significant difference between groups, as the 7th-semester students evoked a greater number of words and vocabulary in three of the four centers of interest (grammar, phonetics and phonology, and discourse) while the third semester students surpassed them in a morphology prompt.

Other studies on the area of specialized lexicon have been developed to understand how the lexicon operates in different work and academic communities, among others. In this context, Guerrero and Pérez (2018) proposed that the specialized lexicon, in connection with the characteristics of the speakers, allows researchers to hypothesize the existence of lexical decentralization, meaning that speakers who have recalled a greater number of specialized vocabulary items in their lists will be the ones with a higher lexical capacity and a high index of decentralization. This means that once the mechanism of lexical association is activated based on the prototype of a center of interest, the research participant updates those words that are closest to the concept proposed by the center. As the research participant moves further away from those central words, less available words appear, meaning they are less *compatible* with the proposed core and are therefore *decentralized*. This would demonstrate greater lexical capacity of the research participants (Callealta & Gallego, 2016).

2.4 Representation of language through graphs

In the area of lexical availability, graph theory has explored the relationship between the terms reported by the subjects in Lexical Availability (LA) surveys. Thus, research on this area has shown that there are certain categorical groupings or associative sets in the lexicon reported by the subjects who participated in lexical availability surveys (Ferreira & Echeverría, 2010; Hernandez & Tomé 2017; Sánchez-Saus, 2016; Sánchez-Saus 2022). In this regard, Hernández (2006) claimed that pioneer studies state that the available words are organized in the form of semantic networks (typical of a connectionist paradigm) but it remains unclear precisely what these networks are like, what formal properties they present or how they are arrived at. Echeverria et al. (2008, p. 82) further explained that "one of the problems faced by cognitive science is that of knowledge representation. Cognitivists must offer theories that allow a modeling of the representations to be used". One of the approaches that attempts to solve this problem is the connectionist approach, based on the associations between different types of information modeled in artificial neural networks.

According to Lehmann (1992), a *semantic network* represents knowledge as a network graph. An idea, event, situation, or object almost always has a composite structure; this is represented in a semantic network by a corresponding structure of *nodes* representing *conceptual units* and directed *edges* representing the *relations* between the units.

Following Lehmann's (1992) semantic network concept, Echeverría et al. (2008) developed DispoGrafo, a computational software, whose aim was to support the psycholinguistic analysis of the terms elicited using lexical availability surveys. It uses an algorithm based fundamentally on the sequence relations of the available words that generate graphs, whose nodes represent words and whose edges symbolize the relations between them. The graphs are interpreted as semantic networks whose configuration expresses the underlying semantic relationships in the corpus.

Continuing along the connectionist line, Salcedo, Del Valle, Contreras, and Pinninghoff (2015) developed the Lexmath platform to quantify and describe the available lexicon in mathematics of high

school students in the town of Concepción, Chile. This platform allows visualizing semantic relations, taking into consideration the frequency of different sequences when evaluating lexical availability. The nodes in the graphs produced by this platform represent words, and the edges represent the relationship between words. The size of the node depends on the number of times a word has appeared in the group responses, while the thickness of the edges depends on the frequency with which the words connected were written in the same order.

In addition to the tools mentioned above, LexPro, a tool for lexical analysis and creation of complex networks, has recently been developed by Universidad de Salamanca and Universidad Miguel Hernández de Elche. It assumes as a theoretical basis that the fact that two words are associated in the same production chain implies a proximity in the mental lexicon. This tool allows the generation of directed, undirected, and linear graphs (Hernández et al., 2023).

To interpret the graphs obtained in Dispografo, Lexmath, or other sources, it is necessary to follow the connectionist constructivist view of Kintsch (1998), who points out that the meaning of a concept/node is defined by its position in the cognitive network in which it participates, that is, by the strength of connection with neighboring nodes, both immediate and more distant. Kintsch (1998) also indicates that the meaning depends on the instance of use, which is why there is an important variability. However, he also indicates that there is a semantic substructure or basic cognitive network that underlies the concept and that remains over time, even though the experience and learning of the subjects would lead to continuous changes.

3. Methodology

To illustrate the knowledge of academic lexicon and mental lexicon in the centers of interest of 1) lesson planning and 2) methods and approaches in language teaching, a mixed approach research was carried out. From the quantitative point of view, empirical evidence is explored through the application of a lexical availability survey and the use of Dispogen II software (Echeverría et al., 2005), which reports the following statistics: average number of responses (AR), number of different words (NDW), cohesion index (CI) and lexical availability index (LAI). From the qualitative perspective, the aim was to describe and show how the students' mental lexicon is organized. For this descriptive analysis, the Gephi software was used, which allows the exploration, navigation, and analysis of graphs. Moreover, graphs can be described using some of the following metrics: network diameter, average grade, graph density, and average clustering coefficient.

This research is non-experimental since there is no manipulation of the independent variables. However, it should be noted that a controlled associative test was used to obtain data, which was artificial, i.e., based on a stimulus that activated the production of lexical items. In this regard, Lopez (1999, p. 32) points out that these tests are "the only ones that make it possible, under experimental conditions, to produce in the linguistic performance lexical units with little statistical stability".

3.1 Participants

The sample consisted of 350 Chilean students with Spanish as L1, who were studying for a BA degree in English Teaching and who receive training in this language (English Medium Instruction). Stratified probability sampling was used (Flick, 2015). This is a sampling procedure in which the target population is separated into exclusive, homogeneous segments (strata), and then a simple random sample is selected from each segment (stratum). The purpose of using this type of sampling is to collect data from students across years of study to analyze and compare any differences between them. Table 1 shows the organization of the sample.

Table 1

Sample Organization by Years of Study

Year of study	*N*
First year (second semester)	118
Second year (fourth semester)	94
Third year (sixth semester)	78
Fourth year (eighth semester)	60

The syllabus of the English teaching program in which students were enrolled at the time of data collection encompasses various subjects that focus on lesson planning, as well as methods and approaches in L2 learning. Table 2 shows the specific classes that each student has completed or is currently taking. Table 2 displays the students' progress in their study program, specifically in language teaching didactics, where themes related to the centers of interest under study are emphasized.

Table 2

Students' Classes Related to the Center of Interest Under Study

Year of study	Class
First year	Teaching Practicum I
Second year	Teaching Practicum II
	Teaching Practicum III
	Methods and Approaches in Language Teaching
Third year	Teaching Practicum IV
	Teaching Practicum V
	Applied Linguistics to Language Teaching
Fourth year	Teaching Practicum VI
	Professional Practice and Feedback Workshop

3.2 Instruments

The instrument used with the students included 2 sections:

1. Subject identification information: name, age, year of entry into the program, current semester, and gender.
2. Lexical availability survey: 2 centers of interest (lesson planning, and methods and approaches in language teaching).

3.3. Procedure

The subjects were informed of the objective of the research and the type of participation requested. Participation was voluntary, and subjects could abandon the study if they wanted, without any penalty.

The researcher read aloud the instructions to all subjects participating in the sample on how to complete the lexical availability survey. This included modelling the activity through an example (see Figure 1). Once the evaluation had begun, the researcher read aloud center one (lesson planning) and provided two minutes for participants to write all the words they could think of, after that, the second center (methods and approaches) was presented.

Figure 1

Lexical Availability Survey Sample

Instructions:

You will have 2 minutes to write down all the English words that come to mind in the topics that the researcher will present. There is no minimum or maximum number of words expected; just write down the words that come to mind.

Researcher says: Write all the words related to "Transport" you know.

Sample Center: Transport
1. Car
2. Bus
3. Plain
4. Truck
(....)
25. Airplane

Center 1:	Center 2:
1.	1.
2.	2.
3.	3.
4.	4.
(....)	(....)
25.	25.

3.4 Data analysis

All tests were coded and processed in Microsoft Excel files, following the order of the answers given by the subjects, and including only the English words present in the survey. The lemmatization of the corpus was done following these criteria: Spanish words and words that do not appear as lexical entries in the dictionaries were discarded.

1. Irregular verb forms and irregular plural nouns (e.g., foot- feet) were retained and counted as different word types.
2. Lexical units with a lexical meaning (e.g., listening-to-music) were considered as lexical units (i.e., counted only as one, not as the sum of the parts).
3. Abbreviations corresponding to approaches and methods were kept e.g., TBL.
4. Spelling errors were corrected.
5. Plural words were changed to singular unless they appeared in plural form in their lexical entry in dictionaries (e.g., sports).
6. Repeated words in the same center of interest were eliminated, therefore, they were counted only once.
7. Verb forms were referred to the bare infinitive, except for the gerund and the participle.

As part of the data analysis procedure, the software Dispogen II (Echeverría et al., 2005) and Gephi 0.9.2 (Bastian et al., 2009) were used. Dispogen II is a MatLab application, which specializes in matrix calculations and multivariate statistical analysis, such as LA analysis. This software provides the following statistics: the average number of words (AW), i.e., the average number of words that the subjects know regarding the center of interest studied; the number of different words (NDW), i.e., the total number of words known by the sample group; cohesion index (CI), i.e., the degree of coincidence in the answers. And finally, a list of words and their corresponding lexical availability index (LAI), showing the degree of availability of a word in the mind of the speaker. Regarding the CI, if the obtained value is close to 1, the CI is higher; consequently, the area of interest is more compact. However, if this value

deviates from 1 (decreasing), the CI is lower; therefore, the area of interest tends to be open or diffuse. On the other hand, the LAI scale ranges from 1 to 0.1, where a value of 1 signifies a word's higher level of availability.

Gephi 0.9.2 is an open-source software that has been developed for graph and network analysis. It uses a 3D rendering engine to display large networks in real-time and to speed up exploration. This software delivers metrics and statistics that reveal the different types of associations observed in a semantic network.

The metrics that are most relevant for the purpose of this research are the following:

1. Nodes: The lexical units present in the network.
2. Edges: Links that allow representing binary relationships between nodes.
3. Average degree: The degree of a node is the number of edges that have an origin or destination in it; that is, it corresponds to the number of words with which it is related (the number of connections that a node has with other nodes).
4. Network diameter: It is the greatest distance between any pair of nodes. The diameter decreases as the network grows.
5. Graph density: The ratio of the number of relationships present in the sample to the total. The density of a network will depend on the size of the sample. It measures how close the network is to being complete. A complete graph has all possible edges and a density equal to 1.
6. Modularity: Measures how well a network decomposes into modular communities, i.e., the set of highly interconnected nodes.
7. Average clustering coefficient: Indicates how the nodes are embedded among their neighboring nodes, basically it measures the density of the connections between the direct neighbors of a node.

4. Results

The results obtained from the analysis of the data derived from the lexical availability survey are presented below. This analysis is organized as follows:

1. Statistigraphs used in lexical availability: number of different words, word average, and cohesion index.
2. List of the top 20 words obtained in each center with their corresponding LAI.
3. Graphs and metrics obtained in each center of interest.

4.1 Statistigraphs

4.1.1 Specialized lexicon

Concerning the total number of words (TW) reported by students, Table 3 shows that at higher years there is a lower number of total words. This could be due to the size of the sample (fewer subjects as the years of study increase). In all groups, it is observed that the center of interest with the highest number of words is lesson planning.

Table 3

Comparative TW by Year of Study

	Center of interest	First year	Second year	Third year	Fourth year
1	Lesson planning	773	1173	1074	889
2	Methods and approaches	474	618	424	437

Table 4 shows the results for the number of different words. Data shows that the center lesson planning has the highest NDW, being second-year students the ones that evoke more words (NDW=329). On the other hand, in the center methods and approaches the maximum NDW is present in 1st year students (158). In general, we cannot observe a tendency in the number of words provided since groups are not homogenous.

Table 4
Comparative NDW by Year of Study

	Center of interest	First year	Second year	Third year	Fourth year
1	Lesson planning	255	329	276	225
2	Methods and approaches	158	138	113	116

For the average number of words (see Table 5), it is possible to note that as the years of study increase, the average number of words increases in both centers. In the case of lesson planning the AW goes from 6.5 in first-year students to 14.8 in fourth year. While in the center methods and approaches the AW goes from 4 to 7.2 words.

Table 5
Comparative AW by Year of Study

	Center of interest	First year	Second year	Third year	Fourth year
1	Lesson planning	6.5	12.4	13.7	14.8
2	Methods and approaches	4.0	6.5	5.4	7.2

Table 6 shows that, in general, the lexicon becomes more cohesive (CI) as the years of study of the subjects in the sample increase. This phenomenon is observed in both centers of interest under study. As for the fourth-year students, the CI is always higher than that of the first-year students, doubling the degree of cohesion. This is probably because there are fewer students at the more advanced years.

Table 6
Comparative CI by Year of Study

	Center of interest	First year	Second year	Third year	Fourth year
1	Lesson planning	0.0256	0.0379	0.0498	0.0659
2	Methods and approaches	0.0254	0.0476	0.0481	0.0628

4.2 List of words

4.2.1 Lesson planning

Table 7 presents the vocabulary of the "lesson planning" center of interest. In this center, it is observed that the words with the highest LAI are *activity, aim, objective*, and *time*. In addition, there are words related to:

1. Class material: *book, worksheet,* and *paper* in the first year, material in 1st, 2nd, and 3rd year, and *aid* in 4th year.

2. Planning objectives: *aim, main-aim, subsidiary-aim, personal-aim,* among others.
3. Stages of a lesson: *warm-up, presentation, development, sequence,* among others.
4. Students' previous knowledge: *anticipated-problem, assumed-knowledge,* among others.

Table 7
Most Available Words and LAI in the "Lesson Planning" Center of Interest

First year		Second year		Third year		Fourth year	
ACTIVITY	**0.2620**	**AIM**	**0.3695**	**OBJECTIVE**	**0.3980**	SUBSIDIARY-AIM	0.4982
TIME	**0.1954**	**TIME**	**0.3360**	**TIME**	**0.3321**	**TIME**	**0.3178**
OBJECTIVE	**0.1736**	**ACTIVITY**	**0.2877**	**AIM**	**0.2993**	**AIM**	**0.3169**
PLANIFICATION	0.1691	OBJECTIVE	0.2628	**ACTIVITY**	**0.2365**	MAIN-AIM	0.3017
CONTENT	0.1513	STUDENT	0,2436	**MATERIAL**	**0.2272**	OBJECTIVE	0.2314
MATERIAL	**0.1197**	TEACHER	0.1675	**WARM-UP**	**0.2036**	ASSESSMENT	0.2268
PLANNING	0.1131	**MATERIAL**	**0.1566**	STUDENT	0.1496	STUDENT	0.2249
PPT	0.0978	PPP	0.1234	MAIN-AIM	0.1490	**ANTICIPATED-PROBLEM**	**0.2163**
STUDENT	0.0955	PRACTICE	0.1048	SUBSIDIARY-AIM	0.1334	**AID**	**0.2072**
WRITING	0.0798	ENGAGE	0.1014	CROSS-CURRICULAR-AIM	0.1304	ACTIVITY	0.1461
BOOK	**0.0751**	CONTENT	0.0992	TIMING	0.1273	PERSONAL-AIM	0.1456
AIM	0.0548	**PRESENTATION**	**0.0984**	APPROACH	0.1169	**ASSUMED-KNOWLEDGE**	**0.1416**
WORKSHEET	0.0546	METHOD	0.0905	PPP	0.1147	TEACHER	0.1173
SCHEDULE	0.0543	APPROACH	0.0837	TEACHER	0.1143	**DEVELOPMENT**	**0.1159**
HOMEWORK	0.0534	TOPIC	0.0817	CONTENT	0.1108	TIMING	0.1084
LISTENING	0.0527	PRODUCTION	0.0807	ENGAGE	0.1024	GRADE	0.1078
PAPER	0.0512	CLASS	0.0769	LEVEL	0.0984	CONTENT	0.1064
TEACHER	0.0497	WARM-UP	0.0724	UNIT	0.0963	WHILE	0.1062
VOCABULARY	0.0497	CCQ	0.0705	DATE	0.0944	PRE	0.1026
STUDY	0.0487	CLOSING	0.0701	SCHOOL	0.0896	TARGET-LANGUAGE	0.0996

It is important to highlight the appearance of the term *planification* among the four most frequently used words by first-year students. In English, this corresponds more to economic or political planning rather than classroom-specific planning, such as planning or *lesson-planning*, which are more appropriate in educational contexts. The emergence of *planification* might directly stem from the translation of the Spanish word *planificación,* commonly used when referring to lesson planning.

4.2.2 Methods and approaches in language teaching

Table 8 presents the words of the "methods and approaches in language teaching" center of interest. In this center, the words with the highest LAI are *audiolingualism, presentation-practice-production, and total-physical-response*. In addition, there is vocabulary related to:

5. Four language skills: *speaking, listening, writing*, and *reading*, and general terminology in approaches and methods: *methodology, method*, and *approach*, in the case of first-year students.
6. Methods: *task-based-learning, silent-way, grammar-translation,* among others.
7. Teaching models: *engage-study-activate, presentation-practice-production,* among others.

8. Techniques: *total-physical-response,* and *drilling,* among others.
9. Approaches: *natural-approach, communicative-approach, lexical-approach*, among others.

Table 8

Most Available Words and LAI in the "Methods and Approaches" Center of Interest

First year		Second year		Third year		Fourth year	
SPEAKING	**0.1927**	SUGGESTOPEDIA	0.3578	**TPR**	**0.5235**	TBL	0.6906
ACTIVITY	0.1883	**AUDIOLINGUALISM**	**0.3505**	**PPP**	**0.4102**	**PPP**	**0.5624**
LISTENING	**0.1433**	**PPP**	**0.3459**	**AUDIOLINGUALISM**	**0.3596**	**TPR**	**0.4857**
WRITING	**0.1227**	**TPR**	**0.3309**	TBL	0.2645	**AUDIOLINGUALISM**	**0.3579**
METHOD	0.1074	SILENT-WAY	0.2824	SUGGESTOPEDIA	0.2263	COMMUNICATIVE-APPROACH	0.2679
TEACHING	0.0991	GRAMMAR-TRANSLATION	0.1945	COMMUNICATIVE-APPROACH	0.2139	SILENT-WAY	0.2677
READING	**0.0954**	NATURAL-APPROACH	0.1894	SILENT-WAY	0.2110	GRAMMAR-TRANSLATION	0.2431
APPROACH	0.0741	TBL	0.1691	GRAMMAR-TRANSLATION	0.1661	ESA	0.1383
LEARNING	0.0730	CLT	0.1428	LEXICAL-APPROACH	0.1096	SUGGESTOPEDIA	0.1107
GRAMMAR	0.0666	DIRECT-METHOD	0.1192	NATURAL-APPROACH	0.1027	CLT	0.0921
GROUP-WORK	0.0602	COMMUNICATIVE-APPROACH	0.1108	DIRECT-METHOD	0.0817	LEXICAL-APPROACH	0.0787
PLANNING	0.0563	LEXICAL-APPROACH	0.0671	CLT	0.0513	DIALOGIC-PEDAGOGY	0.0700
METHODOLOGY	0.0535	TEACHER-TALKING-TIME	0.0622	DIALOGIC-PEDAGOGY	0.0411	CONSTRUCTIVISM	0.0668
MATERIAL	0.0515	STUDENT-TALKING-TIME	0.0589	CAE	0.0359	BEHAVIORISM	0.0592
PAIRWORK	0.0514	ARMY-METHOD	0.0567	ECLECTIC-APPROACH	0.0276	PROJECT-BASED-LEARNING	0.0585
COMMUNICATION	0.0427	ESA	0.0542	METHODOLOGY	0.0275	INTERACTIVE-METHOD	0.0497
LESSON-PLAN	0.0423	REALIA	0.0407	ESA	0.0253	DRILLING	0.0495
TALKING	0.0369	CLL	0.0321	INDUCTIVE	0.0224	CBL	0.0481
VOCABULARY	0.0367	CCQ	0.0304	BEHAVIORISM	0.0207	DIRECT-METHOD	0.0430
WORKSHEET	0.0355	TEACHING	0.0295	DRILLING	0.0197	INTEGRATED-SKILLS	0.0380

4.3 Graphs and metrics

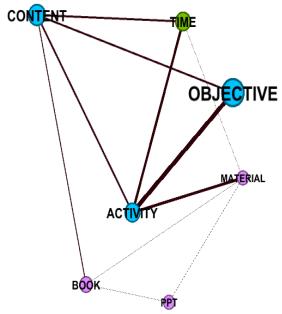
The following section presents the graphs and metrics centers of interest under study.

4.3.1 Graphs and metrics in lesson planning center of interest

In Figures 2 and 3 we can see the semantic relationships present in first-year students in the lesson planning center of interest. In Figure 2 the number of nodes amounts to 7, the strongest being OBJECTIVE, CONTENT, TIME, and ACTIVITY. This suggests that these are the most available words in first-year students when thinking about the lesson planning axis. It is observed that the words with the highest number of links are CONTENT, ACTIVITY, and MATERIAL, which have 4 links each; this means that these words are associated with 4 other words.

Figure 2

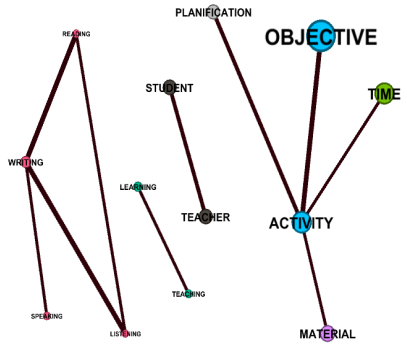
Node Graph, 1st-year, Lesson Planning



In Figure 3, it is possible to observe that the strongest link is between the words OBJECTIVE and ACTIVITY, which correspond to the objective with which planning is carried out and to the activity that students perform. Likewise, an equally strong link is observed between the words WRITING and READING; and WRITING and LISTENING, which correspond to 3 of the 4 linguistic skills that are central axes of planning in an English lesson.

Figure 3

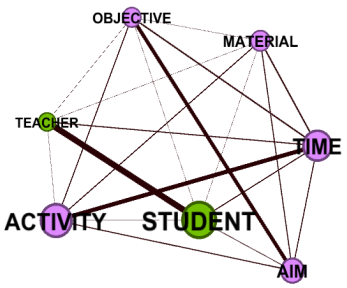
Edge Graph, 1st-year, Lesson Planning



In Figures 4 and 5 we can observe the semantic relationships present in the 2nd year students in the lesson planning center of interest.

Figure 4

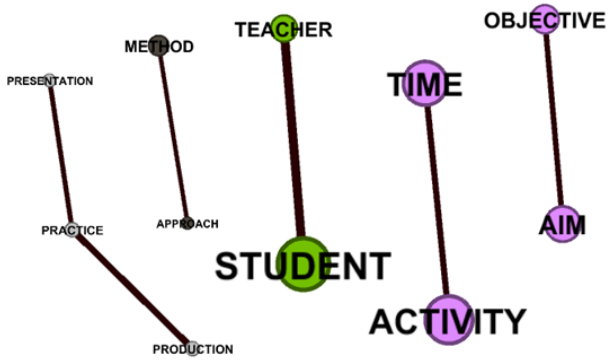
Node Graph, 2nd-year, Lesson Planning



In Figure 4 the number of nodes amounts to 7, the most mentioned words being STUDENT, ACTIVITY, and TIME. This suggest that these are the most available words in the 2nd year students when thinking about the lesson planning axis. At this level, it is observed that except for TEACHER and AIM (5 links), all the other nodes have 6 links.

Figure 5

Edge Graph, 2nd-year, Lesson Planning

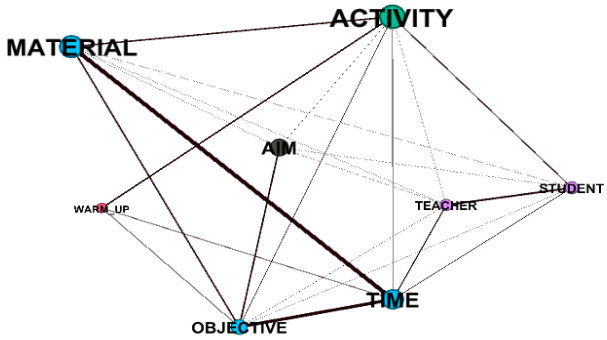


In Figure 5 it is possible to observe that the strongest link is between the words STUDENT and TEACHER, which correspond to the student and his or her characteristics as the central element of planning, and the teacher. A strong link is also observed between the words PRACTICE and PRODUCTION, which correspond to two elements of the teaching model: presentation, practice, and production (PPP).

In Figures 6 and 7 we can observe the semantic relationships present in the third-year students in the lesson planning center of interest.

Figure 6

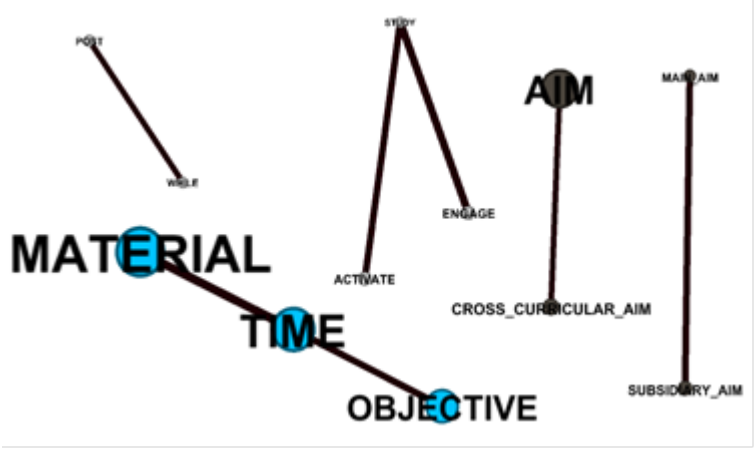
Node Graph, 3rd-year, Lesson Planning



In Figure 6 the number of nodes amounts to 8, the most mentioned words being ACTIVITY, MATERIAL, and TIME. This suggests that these are the most available words in 3rd grade students when thinking about the lesson planning axis. It is observed that the words with the highest number of links are ACTIVITY and OBJECTIVE with 7 links.

Figure 7

Edge Graph, 3rd-year, Lesson Planning

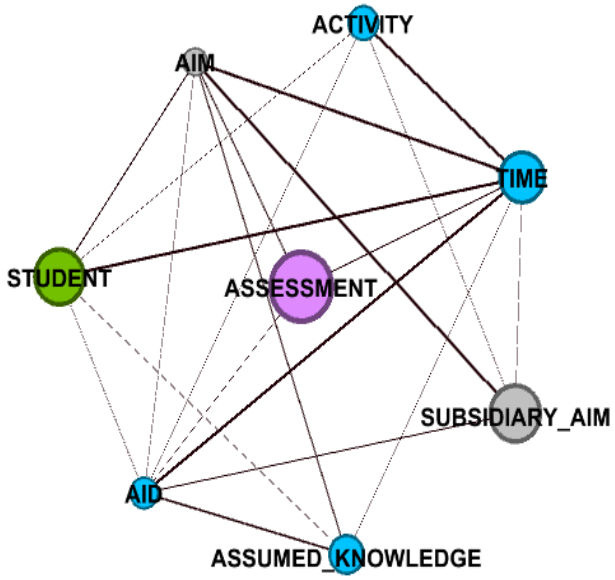


In Figure 7 it is possible to observe that the strongest link is between the words TIME and MATERIAL, which corresponds to two important elements in planning, time, and the material to be used. A strong link is also observed between the words ENGAGE and STUDY, which correspond to two elements of the engage-study-activate teaching model.

In Figures 8 and 9 we can observe the semantic relationships present in fourth-grade students in the lesson planning center of interest.

Figure 8

Node Graph, 4th-year, Lesson Planning



In Figure 8 the number of nodes amounts to 8, being the most mentioned words ASSESSMENT, TIME, STUDENT, and SUBSIDIARY-AIM. This suggests that these are the most available words in fourth-grade students when thinking about the lesson planning axis. It is observed that the words with the highest number of links are TIME and AID with 7 links.

Figure 9

Edge Graph, 4th-year, Lesson Planning

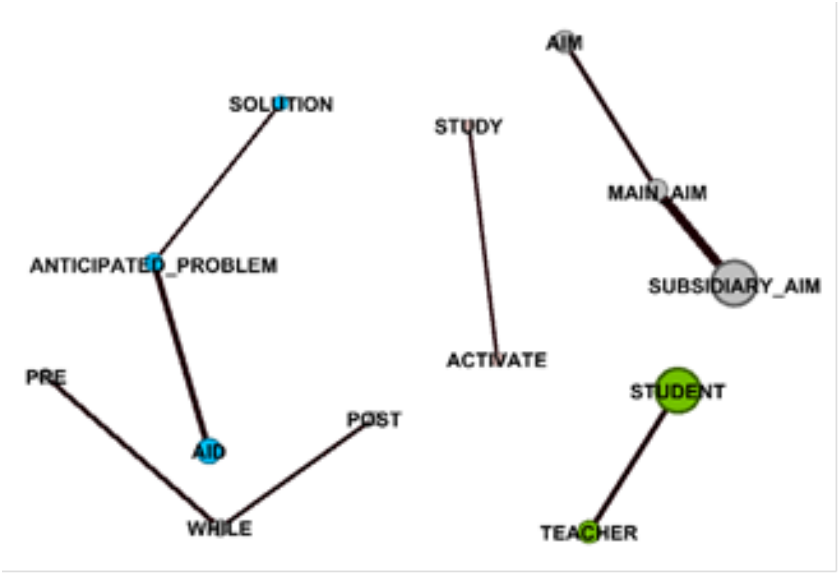


Figure 9 shows that the strongest link is between the AIM and SUBSIDIARY-AIM nodes, which correspond to the main objective and the subsidiary objective. There is also a strong link between the AID and ANTICIPATED-PROBLEM nodes, which correspond to the aid (resources) and the expected problems before planning the lesson.

When comparing the metrics provided by Gephi (see Table 9), we can point out that:

10. The average grade is higher in third and fourth-year students, which shows that in these levels there are more connections between the words that were mentioned in this center.
11. The network diameter is greater in first-year students (11), which would indicate that their network is the smallest. On the other hand, the smallest diameter is observed in the second, third, and fourth years (10).
12. The graph density indicates that fourth and third-year students generated the densest graphs. On the other hand, the other levels presented a lower density, which fluctuates between 0.016-0.018.
13. The highest modularity is found in first-year students (0.481), while the lowest modularity is found in third-year students (0.417).
14. The average clustering coefficient is higher in fourth-year students (0.154), while the lowest coefficient is observed in third-year students (0.125).

Table 9

Metrics of the Lesson Planning Center

Lesson planning	First year	Second year	Third year	Fourth year
Nodes	255	329	276	225
Edges	545	878	793	628
Average grade	4.275	5.337	5.746	5.582
Network diameter	11	10	10	10
Graph Density	0.017	0.016	0.021	0.025
Modularity	0.481	0.446	0.417	0.442
Average Clustering Coefficient	0.149	0.14	0.125	0.54

4.3.2 Graphs and metrics in methods and approaches center of interest

In Figures 10 and 11 we can observe the semantic relationships present in the first-year students in the center of interest methods and approaches.

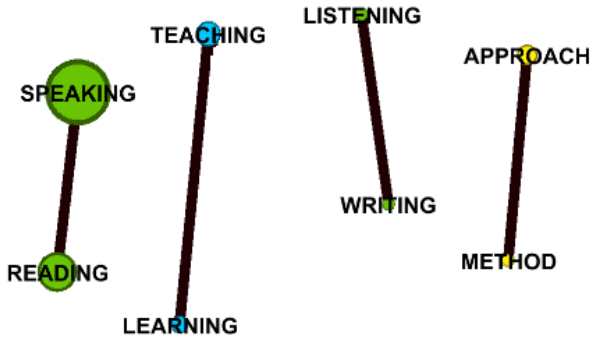
In Figure 10 the number of nodes amounts to 5, the most mentioned words being SPEAKING and MATERIAL. This suggests that these are the most available words in first-year students when thinking about the axis methods and approaches. The cluster SPEAKING and READING is also observed.

Figure 10

Node Graph, 1st-year, Methods and Approaches

Figure 11

Edge Graph, 1st-year, Methods and Approaches



In Figure 11 it is possible to observe that the strongest links are between the words SPEAKING and READING, which correspond to oral and written production skills; TEACHING and LEARNING, teaching and learning concepts; LISTENING and WRITING, listening and writing skills; APPROACH and METHOD, approach and method concepts.

In Figures 12 and 13 we can observe the semantic relationships present in the second-year students in the center of interest methods and approaches.

In Figure 12 the number of nodes amounts to 7, being the most mentioned words SPEAKING, TPR, and ACTIVITY. This suggests that these are the most available words in the second year when thinking about the axis methods and approaches. It is observed that the highest number of links is in the nodes TPR and SUGGESTOPEDIA (4).

Figure 12

Node Graph, 2nd-year, Methods and Approaches

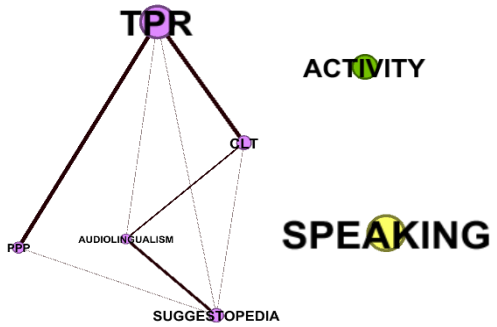
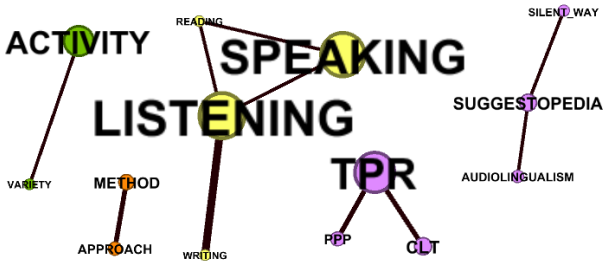


Figure 13

Edge Graph, 2nd-year, Methods and Approaches



In Figure 13 it is possible to observe that the strongest link is between the words LISTENING and WRITING, which correspond to two linguistic skills. We can also observe a link between TPR and PPP, technique and model; TPR and CLT, technique and approach; and METHOD and APPROACH, which correspond to the word method and approach.

In Figures 14 and 15 we can observe the semantic relationships present in third-year students in the center of interest methods and approaches.

In Figure 14 the number of nodes amounts to 8, the most mentioned words being AUDIOLINGUALISM, TPR, TBL, and SUGGESTOPEDIA. This means that these are the most latent words in third year when thinking about the axis methods and approaches. It is observed that except for GRAMMAR-TRANSLATION, COMMUNICATIVE APPROACH, and PPP, all the other nodes have 7 links.

Figure 14

Node Graph, 3rd-year, Methods and Approaches

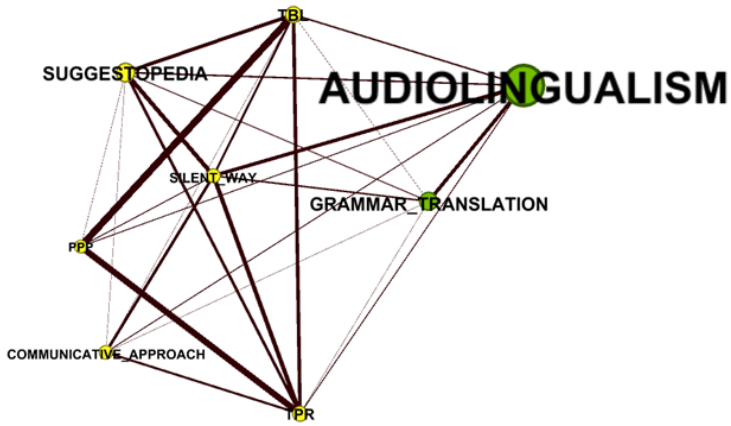
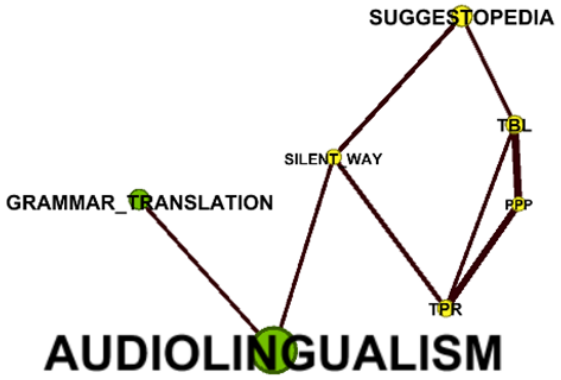


Figure 15

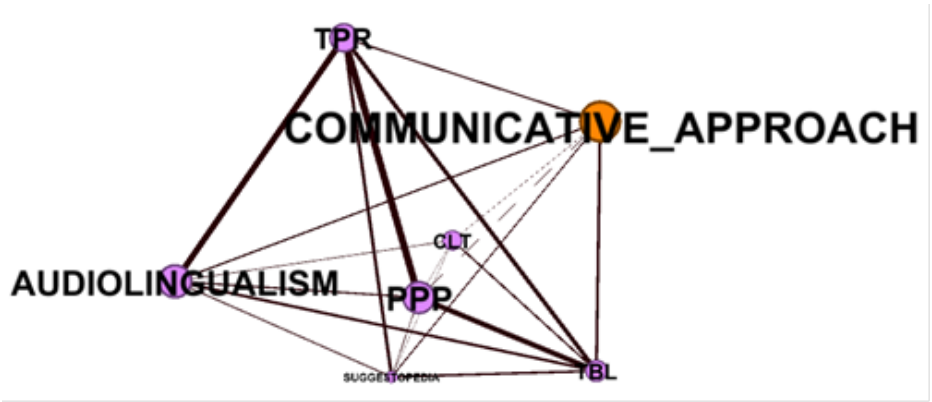
Edge Graph, 3rd-year, Methods and Approaches



In Figure 15 it is possible to observe that the strongest link is between the words TBL and PPP, two different methodologies. A link between PPP and TPR is also observed, a method (PPP) that can include this technique (TPR) in the practice stage. In Figures 16 and 17 we can observe the semantic relationships present in the third-year students in the center of interest methods and approaches. In Figure 16 the number of nodes amounts to 7, the most mentioned words being COMMUNICATIVE APPROACH, AUDIOLINGUALISM, and TPR. This suggests that these are the most available words in the third year when thinking about the axis methods and approaches. It is observed that apart from TPR and CLT (5), all the other nodes have 6 links.

Figure 16

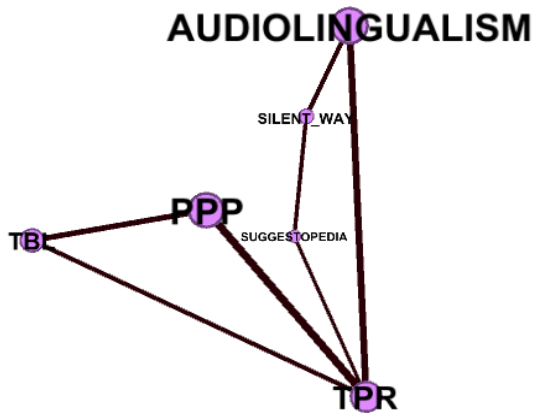
Node Graph, 4th-year, Methods and Approaches



In Figure 17 it is possible to observe that the strongest link is between the words PPP and TPR. A link is also observed between TPR and AUDIOLINGUALISM, technique and approach; followed by PPP and TBL, teaching model and method.

Figure 17

Edge Graph, 4th-year, Methods and Approaches



When comparing the metrics provided by Gephi (see Table 10), we can point out that:

1. The average grade is higher in second-year students, which shows that at these levels there are more connections between the words that were mentioned in this center.
2. The network diameter is greater in second-year students (15), which would indicate that their network is the smallest. On the other hand, the smallest diameter is observed in the first and fourth years (12).
3. The graph density indicates that the fourth-year students generated a denser graph. On the other hand, the lowest density is observed in the first-year students, which is 0.02.
4. The highest modularity is observed in first-year students, while the lowest modularity is evident in fourth-year students.
5. The average clustering coefficient is higher in fourth-year students (0.187), while the lowest value is observed in first year (0.131).

Table 10

Metrics of the Methods and Approaches Center

Methods and approaches	First year	Second year	Third year	Fourth year
Nodes	158	138	113	116
Edges	252	295	189	226
Average grade	3.19	4.275	3.345	3.897
Network diameter	12	15	13	12
Graph Density	0,02	0.031	0,03	0.034
Modularity	0.627	0.354	0.399	0.331
Average Clustering Coefficient	0.131	0.182	0.187	0.151

5. Discussion

The results allow us to highlight the following findings: as the years of study of the participants in the sample increase, the AW and CI in the centers under study also increase. This finding is in line with research that has been conducted with students at different stages of academic development, in which an

increase in the average number of responses and an increase in the cohesion index is observed (Urzúa et al., 2006, Salcedo and Del Valle, 2013, Ferreira et al., 2014, Rojas et al., 2017). This is related to the evidence found from the change that occurs in the students' mental lexicons, which according to Del Valle et al. (2016, p. 145), "increases, decreases and changes dynamically, being permeated by the context surrounding the individual and the moment of life in which he or she finds him or herself". Considering then, that there is a link between this change and students' learning process that serves as evidence of their cognitive processing and development (Stella et al. 2024), involving processes such as memory, attention, and comprehension. As students integrate new linguistic information into their existing mental frameworks, their cognitive abilities are further refined and strengthened.

The 20 most available words according to their LAI, tend to be similar among all the years under study. However, there is evidence of the presence of general vocabulary in the first year and greater specificity and/or relevance as students' progress through the curriculum. These findings show "a clear trend in the transformation of the available lexicon towards an availability of more technical vocabulary and specific to each area, as students stay longer at the university" (Rojas et al., 2017, p.11). Furthermore, the identification of highly AW has practical implications for teacher education in EMI contexts given the fact that learning takes place in the target language, aligning with the recommendations of Bonorino and Cuñarro (2006) who emphasize the importance of vocabulary mastery for the comprehension and production of knowledge, as without vocabulary acquisition, there would be no learning of the subject matter.

With respect to the representation of the mental lexicon through graphs, it is relevant to note that its usage has enabled a clear identification of key concepts in the student's mind, as well as the interconnectedness among them. As stated by Kintsch (1998), the meaning of a concept is defined by its position in a cognitive network, and this network evolves with experience and learning. Based on this, it was possible to determine the changes that occurred in the students' mental representation as they progressed in their study plan, revealing an increased disciplinary mastery. The progression evidenced goes beyond mere word acquisition; it sheds light on their evolving perception of reality. As students progress in their studies, they not only learn vocabulary but also internalize the fundamental concepts, shaping their comprehension of the subject matter. So, this deeper understanding shows a transformative process where they develop a more refined perspective on the discipline they are studying. As an example of this, when analyzing the node graphs for the *lesson planning* networks, it becomes evident that the subjects in the sample consider *time, activity, objective*, and *content* as central elements in the lesson planning process, without overlooking the *students* as the central axis. Furthermore, for fourth-year students, the *assessment* element is also incorporated. On the other hand, when analyzing the edge graphs, strong relationships are observed between the concepts of *student-teacher*, *time-activity-objective-materia*l, and in the case of fourth-year students, the cluster *anticipated-problem-solutions* emerges. This illustrates students' understanding of the different elements of lesson planning, with fourth-year students exhibiting more sophisticated understanding, likely due to their extended learning trajectory.

In summary, this research shows that as pre-service teachers progress through their years of study, they acquire more specialized academic vocabulary and develop interconnected cognitive networks which evidence deeper subject knowledge. Moreover, the visual representations of their cognitive networks portray the changing importance of key concepts over time.

6. Conclusion

In conclusion, this study sheds light on language development in students as they progress through their academic journey. In this case, the shift towards more specialized and technical terminology highlights the dynamic nature of the mental lexicon and the importance of supporting students in acquiring domain-specific language.

However, it is important to point out that the lack of group homogeneity among surveyed learners creates significant challenges in comparing findings among these groups. The data, cohesion index and semantic networks are heavily influenced by the number of individuals surveyed. Therefore, the main purpose of this paper is to identify trends in the addressed issues rather than draw conclusive findings from direct group comparisons. Given that there is little research on lexical availability in EMI contexts, this study allows us to identify topics to examine through further research in this area.

Also, from the data obtained, it is possible to mention that lexical availability and semantic networks allow us to know students' active vocabulary, identify possible gaps or needs and intervene in the teaching process with remedial measures, when necessary, as the data collected provides information regarding their conceptualization of reality (Navarro, 2009; Hidalgo, 2017).

Overall, these findings emphasize the dynamic and context-dependent nature of language development, offering valuable insights for educators in improving language instruction and curriculum design. Understanding how students' language abilities develop alongside their cognitive networks allows educators to adapt teaching methods to suit learners' changing needs, thereby improving language education programs. Pedagogical implications involve utilizing these findings to enhance teaching practices, particularly in English as a Medium of Instruction (EMI) contexts, by prioritizing vocabulary mastery for improved comprehension and knowledge production.

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