Error Analysis on Air Traffic Controllers' Aviation English Performance

MASTER'S REPORT

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Dedication and Acknowledgments

To God, for blessing me every day, for giving me strength, guiding me through
the right path, and showing me how big His love is.

To my beloved wife Carolina and my son Juan Pablo, you give meaning to my
life. Thank you for supporting me every time I needed, being my inspiration and
the reason for achieving better things.

To my mom, my total gratitude. For being there supporting me and showing me
with your love what really matters.

To Diana, for her support and patience, and for being an example to follow.

To my master's teachers for their patience and teachings.

To my classmates Martha and Diego, for their friendship and constant support.

Abstract

This study aimed to analyze the effects of a corrective strategy on a group of Air traffic controllers' awareness of the errors affecting oral communication. The research is based on a descriptive-qualitative study, in which data collection included surveys, interviews, and the performance of simulated air traffic controllers' duties using the exact parameters of accurate operation and English aeronautical rules. The information gathered from the analysis was incorporated into ATCs' needs analysis and used to design an intervention strategy to improve ATCs' English oral interactions during their duties. The training program was designed to develop self and peer correction strategies in ATCs looking to improve participants' levels and share these strategies with their partners. After the intervention, participants' perceptions showed that they feel more confident about using EFL in their duties and correct their pronunciation by implementing IPA and phonology techniques.

Keywords: error analysis, aviation English, air traffic control.

1. Introduction

Every day pilots need to communicate effectively with ground staff everywhere, and these interactions are conducted in English. Air traffic controllers guide pilots and provide the information to fly safely and orderly. In the Colombian context, Air Traffic Services (ATSs) are provided in the official language: Spanish; however, if pilots cannot communicate in Spanish, ATSs will be provided in English.

The study was focused on a group of air traffic controllers' English oral performance in aeronautical communications. In their jobs, they normally use radio transmitters where oral interaction is the only option; simultaneously, radio communication spans are minimal, so communications need to be precise avoiding repetitions or excessive conversation time. This error analysis on air traffic controllers' English performance was aimed to identify the most common errors that could affect aeronautical communications and determine to what extent awareness of those errors can improve EFL air traffic controllers' interactions. Although air traffic controllers participating in the study are settled in Cali, participants are interested in improving their English performance in aeronautical and plain English as they consider English a key element for their job.

The process was developed in three main stages; at first, participants were convened to participate in the process. As part of the initial characterization, first, I identified their communicative needs and expectations. Then, the data was collected through individual simulated air traffic control sessions to identify the most common errors and analyze them according to their frequency and relevance in aeronautical communications. After the error analysis, the intervention was designed considering their needs and the error analysis findings. Finally, the impact of the interventions was determined by interviewing some of the participants

establishing to what extent awareness of commonly performed errors, allowed ATCs correcting

them covering their expectations and needs in English oral performance. With this study, I aimed

to generate awareness among EFL users about error production and the corrective strategies that

could be implemented to improve their oral production.

The report was divided into sections following the sequence of the project

implementation. In the first section, I defined my research interest, stated the problem, and stated

the research question and objectives. In the next section, I conducted a literature review looking

for previous studies related to the English aeronautical context and error analysis on recordings

focused on oral performance analysis. Then, in the methodology section, I established the

particularities on implementing the interventions and data collection and analysis. Finally, in the

next section, I explained the intervention designed from the data analysis and the results

collected after those interventions, including participants' perceptions and conclusions from my

perspective as an EFL teacher. The report also included the analysis of the external factors

affecting EFL learning processes inside air traffic controllers' environments and proposed

alternatives to cope with these limitations.

2. Problem statement

2.1 Justification

Aviation safety requires specialized technology and high standards on human factor development and training (Petrashchuk, 2016). The global range of aviation operations requires setting a standard language, avoiding misunderstandings and flaws in aviation safety communications. English has been adopted as a lingua franca for aviation (Petrashchuk, 2016); this decision has created a subculture and sublanguage called English for aviation (Community of practice) that includes three main topics: English for Specific Purposes (ESP), English for General Purposes (EGP) and Aeronautical Standard Phraseology (ASP), (Hamzah, & Fei,2018). Covering English for aviation standards has become a must for both native and non-native speakers. Pilots and air traffic controllers need to be trained and assessed on the use of aeronautical expressions, focused on each one of the three topics related to English for aviation performance.

The specificity of English for aviation makes it challenging to implement English for aviation learning programs beyond the basic training programs at aviation training centers. Due to the lack of aviation context on most EFL teachers, it is a common practice for air traffic controllers to conduct English training exercises based on repetition and imitation from the more experienced controllers. However, this strategy also copies errors, including the ones on the standard language taught to trainees. Air traffic controllers' training programs focus ELT on preparing ATCs to face most of the routine situations presented on actual flight operations through ASP. Language issues on ATCs performance are primarily evident in nonroutine situations, where it is required the implementation of EGP mixed with ASP in a functional code mixture (Emery, 2016). Error analysis study and corrective strategies implementation aim to

provide EFL learners with tools to conduct self and peer corrections based on performance analysis.

According to participants' needs, this study is focused on oral performance rather than reading or writing skills. Aeronautical English requires a practical and precise approach to EFL use focused on transmitting precise data and instructions and understanding the information in short messages during the interactions between pilots and controllers. These interactions are limited to radiotelephonic communications, demanding a more structured and precise use of oral communicative competence. As a former Air traffic controller and current EFL teacher, I understand the specificity of aeronautical English, its differences, and its similarities with general English used in social interactions. This expertise allowed me to conduct a precise and detailed error analysis, provide well-structured and solid feedback, and generate awareness about EFL use on air traffic controllers.

The intervention implemented in this study aimed to develop awareness on errors performed, allowing self and peer correction strategies on air traffic controllers as a corrective method, thus, fostering the continuous improvement on English for aviation oral interaction production. The intervention included the knowledge of tools like the International Phonetical Alphabet (IPA) and phonetic rules to foster awareness of EFL. In this sense, the purpose of this study was to determine to what extent an intervention designed considering error analysis findings and learners' needs can develop EFL errors awareness, improving English oral interaction skills on air traffic controllers.

2.2.   Research question

How did an error analysis intervention strategy affect a group of air traffic controllers' English oral interaction performance?

2.3.   Objectives

2.3.1. General objective

To analyze the effects of a corrective strategy on a group of Air traffic controllers' awareness of the errors affecting oral communication.

2.3.2. Specific objectives

- ✓ To conduct an error analysis on air traffic controllers' oral English performance.
- ✓ To identify air traffic controllers' awareness of their errors and oral performance before and after implementing an error analysis intervention strategy.
- ✓ To design an intervention strategy based on error analysis findings and needs analysis.

3. Literature review

Nowadays, aviation has become a global industry, and for that reason, English has been established as the common aviation language worldwide. International civil aviation organization (ICAO) sets a minimum competence in English to ensure effectiveness in aeronautical radio communications between pilots and air traffic controllers (ATC). The focus of ICAO aviation English competence is oral communications. The main concern related to aviation English is communication flaws between pilots and ATCs when both are non-native English speakers (NNES), affecting aviation safety. Several studies worldwide have demonstrated the implications of error analysis and linguistic strategies implementation in aviation English performance improvement. The present literature review aims to understand the context and previous studies' conclusions related to error analysis on ATCs performance and the impact of this kind of intervention in aviation English users.

To provide a frame for error analysis implementation, the literature review was structured in a logical sequence. At first, the aviation English background explained by Petrashchuk (2016) as a lingua franca in aviation allows a better understanding of the research field's specificity. Second, I analyze previous error analysis studies on ATCs recordings transcriptions like Hamzah & Fei (2018) study. After considering these elements, I centered the analysis on aviation English key elements suitable for studying in-depth. By the end of the literature review, I focused my attention on designing an intervention plan based on error analysis findings, including material design and assessment strategies. The literature reviewed during the research design allows me to define a clear framework for the implementation of error analysis and intervention strategy.

3.1. Aviation English

The global expansion of aviation has demanded the evolution of other global dynamics; one of the most important is language. As aviation has reached new places and cultures, adapting and adopting new communication strategies has been necessary, allowing a safe introduction of aviation in local contexts. According to Petrashchuk (2016), English has been internationally agreed as the standard language for aviation, and it is the critical element of communications that allows aviation to be operated worldwide. In Breul (2013) words, Aviation English emerges as "a semi-artificial language based on English that serves as the standard means of verbal communication between pilots and air traffic controllers" (p. 71). Based on the previous considerations, the concept of Petrashchuk (2016) of "English as a kind of lingua franca for aviation" (Petrashchuk, 2016, p. 90) explains how aviation English context involves among others: operational environments like radiotelephonic communications and operators' interactions like on-ground services and passengers' interactions.

One of the main characteristics of aviation English is the precision and specificity of language to provide safety to air operations. Petrashchuk (2016) considers the concept of register, applied to aviation English based on "a zero-tolerance level for error applied in aviation" (Petrashchuk, 2016 p. 91), that reduces the field of aviation English use to a group of aviation experts directly involved in air operations. For Petrashchuk (2016), within Aviation English, a variety of English used in radiotelephony settings as a particular spoken discourse aimed to achieve air operations safety. These register and varieties are limited to the strict regulations and requirements prescribed by International Civil Aviation Organization (ICAO) in its master document Doc. 4444 and its appendixes related to English for aviation (ICAO, 2016). Aviation English specificity plays a determinant role in its performance; non-native and native speakers

need to be trained and gain expertise in its use. However, Petrashchuk (2016) analyses how plain English proficiency flaws in NNESs, affect safety, especially in nonroutine situations.

3.2. Air traffic control English

Within the specificity of aviation English, Breul (2013) considers a kind of "semiartificial English-based sub-language" employed by air traffic controllers (ATC) that he calls ATC-English. Even though this sub-language is very important in the aviation context, it has not been widely studied within English for specific purposes (ESP) and Language for specific purposes (LSP) research. Philips (1991) and Vatnsdal (1987), cited by Breul (2013), consider the main ATC-English characteristics related to rules, priorities, codes, standardized expressions, and skeleton messages (phraseology). On the other hand, Breul (2013) contrasts natural and ATC-English at a very linguistic level, highlighting phonology, lexis, and syntax differences. Even if natural and ATC-English seem to work separately, both are closely interrelated. ATC-English is the common aviation language and codification used in aviation staff called "normal operations." In contrast, plain or natural English is used in nonroutine or emergencies, where extra information is expressed, and unplanned situations need to be assisted.

3.3. Aviation English in pilot-controller interactions

In 1944 ICAO established English as the language used for aeronautical communications in all countries worldwide, even in countries where English was not the mother tongue or a second language. In 2010, ICAO established the minimal English proficiency requirements for pilots and ATCs and defined the assessment procedures to certify these proficiency levels, focusing mainly on ICAO's oral performance (2010). According to Breul (2013), English is a lingua franca for aviation, used mainly by pilots and ATCs in operational contexts to develop air

operations safely. For Hamzah & Fei (2018), Regardless of aeronautical authorities' efforts to assure aviation English competence, inadequacy in English proficiency amongst NNESs pilots and controllers has produced miscommunications and safety risks in air operations. On the other hand, radiotelephony communications between NESs and NNESs could also present miscommunications and safety issues.

According to Mitsutomi and O'Brien (2003), cited by Hamzah & Fei (2018), aviation English consists of three main categories: English for General Purposes (EGP), English for Specific Purposes (ESP), and ATC Phraseology. Aviation English users are trained to identify the different situations to use each one of these categories or a combination of them. ATC phraseology and ESP are commonly used separately or mixed for routine and standard communications. In contrast, ESP and EGP or a mix of them are mainly used in nonroutine or emergencies.

3.4. Miscommunications in pilot-controller interactions

After setting the main characteristics of aviation English and how it is used in pilot-controller interactions, I need to define miscommunication. According to Brenner (1996 cited by Hamzah & Fei, 2018), miscommunication occurs when the message perceived by the listener is coherent for him/her but differs from the message emitted by the speaker. In a more precise definition in the aviation field, for Simmons (1974) cited by Hamzah & Fei (2018) miscommunication in the aviation context refers to a misinterpretation of the instruction by the pilot or controller that occurs by the absence of an incomplete instruction readback.[1]

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[1] Aeronautical radiotelephony communication procedures have tools like the message readback designed to avoid misunderstandings, letting the speaker know if the message was correctly perceived or if it needs to be repeated.

Language is a human ability that allows people to interact with them in different ways; in the specific case of this research, I am going to consider, among others, the way these interactions are affected by human factors. For Chang, Wang, Tsai, Hsu, Yen, J. R., & Ho, (2007), ATC phraseology in aviation operation must accomplish the minimal criteria of accuracy, correctness, and certainty; in addition, the rapid global expansion of the aviation industry has made the issues related to miscommunications more serious. In their study, Chang et al. (2007) analyzed human factors, among others: social behavior, culture, and cognition ability, from ATC recordings transcriptions quantitative and qualitatively. Their conclusions pointed out that external factors unrelated to human performance have more influence in miscommunications than those related to human performance. In Hamzah & Fei, (2018) words, the most common signs of miscommunication are among others: inappropriate response, requests for repetition, absence or wrong readback, hesitation, and silence (Hamzah, & Fei, 2018, p. 201).

3.5. Aviation English components

There are several definitions of aviation English as this concept requires integrating characteristic components in a functional subject. According to Bieswanger's (2016) definition, aviation English is "the English used in voice-based air traffic control communication" (Bieswanger, 2016, p. 68); this definition looks simple but covers the core of aviation English in practice. Binswanger's (2016) document is focused on the analysis of aviation English from the perspective of register research. In his study, he states the possibility that aviation English is formed by two different registers: standardized phraseology and plain English. Biber and Conrad (2009), cited by Bieswanger (2016), cited three components for considering in a register analysis: situational context of use, linguistic analysis, and interaction of linguistics in such context.

ICAO, in its Document 9835 (2010), refers to specific aeronautical context vocabulary and expressions as "The formulaic code made up of specific words that in the context of aviation operations have a precise and operational significance" (ICAO 2010, Section 6.2.8.4, p, 66). The code must be combined with plain English in situations requiring the mixed code (aviation and plain English) to ensure communication and safety in air operations. In the cited document, ICAO sets the six criteria to be considered in the Language Proficiency Requirements (LPR): pronunciation, structure, vocabulary, fluency, comprehension, and interactions. Such components aim to test the speaker's ability to use a mixed code that includes coded and uncoded English to assure the transmission of the messages. Emery (2016) considers that pilots' and ATC's training programs should include using the mixed code to accomplish ICAO LPRs and assure operational safety.

The register analysis performed by Bieswanger (2016) and the mixed code considered by Emery (2016) express similar concepts and ideas. Code and phraseology work in routine situations as standard and well-structured instructions provide precise instructions and commands, avoiding misunderstandings under everyday situations. On the other hand, plain English provides a complementary field not regularly used but required to cope with the most challenging situations ATCs and pilots face, like contingencies and emergencies. In general, even though both registers are designed to work separately, the best option is to mix them in a functional communicative strategy to cover routine and nonroutine situations in air operations.

3.6. Regional accents and English aviation performance

After considering the human factor in aviation safety incidents, it is time to explore the situations related to air accidents and incidents deeply. According to EUROCONTROL (2004, 2006) cited by Tiewtrakul & Fletcher (2010), the most frequent factors contributing to ATC

errors are controller's accent and speech rate. One reason for standard aeronautical phraseology is precisely avoiding regional expressions and accents in aeronautical communications. However, during the use of plain English under stressful situations, those expressions and cultural interpretations could appear and affect messages' effectiveness. Cushing (1994), cited by Tiewtrakul & Fletcher (2010), states that language characteristics such as linguistic elements among others: ambiguities in meaning/harmony, word order and rules of English, can derive from miscommunications as the mind processes information heard in different ways. This situation can be worse with NNES because of some linguistic elements misuse.

As previously stated, based on Tiewtrakul & Fletcher (2010), non-standard phraseology messages are more affected by this situation, as the speaker needs to include plain English expressions in these messages. Such situations tend to increase when both: controllers and pilots are NNESs even if they are proficient according to ICAO LPRs. NNESs communication problems, according to Itokawa (2000), Henley & Daly (2004) (cited by Tiewtrakul & Fletcher,2010), are mainly associated with interactions with NESs whose speech is faster and less comprehensible for NNESs. It is more difficult for to NNESs perceive the differences in pronunciation because of their accent influence and preconceptions of language. At the same time, NNESs language production is also affected by regional accent and particular characteristics; in this case, it is more manageable for NESs to cope with them, but NNES message receivers could have more difficulty to understand messages.

3.7. Intercultural communicative competence in aviation English

Intercultural awareness is one of the most critical elements in communication. Although Aviation English acts as an intercultural bridge among people worldwide, according to Hazrati (2015), cultural awareness in aviation English requires much attention because of its impact on

different cultures worldwide. Furthermore, Hazrati states that cultural diversity generated by the multiple nationalities' contexts, where aviation English is used as a lingua franca, requires considering the interlocutor's cultural background more than just the aviation community of speech background.

Understanding cultural differences in aviation English communication users contributes to avoiding miscommunications between pilots and ATCs, especially in nonroutine situations. In the words of Hazrati (2015), "the learning goal of interculturalization is not the assimilation to norms of the target culture, but it is an expansion of the intermediate position" (p,245); this extract explains the need for intercultural empathy and awareness development as the means for improving comprehension and fluency competence in aviation English, especially among NNESs.

The development of intercultural awareness helps both NESs and NNESs to understand easily spoken communications produced by NNESs who are highly influenced by their native language. According to Hymes (1972) cited by Hazrati (2015), the development of grammatical competence and the proper use of language are necessary for appropriate use of language; however, the development of sociolinguistic competence is also needed to acquire communicative competence. A better understanding of interlocutor particularities such as the knowledge of the country and general knowledge of the world and its diversity helps the speaker develop empathy and identify common elements in speakers' contexts that help to have better communication among them. Hazrati (2015) also considers the routinization generated by standard phraseology and the impact that intercultural awareness could have in preventing miscommunications among pilots and ATCs, by increasing the willingness to communicate and the negotiation of meaning beyond the simple reception of standardized messages.

3.8. Materials for speaking skills in aviation English

Material design is an essential element in the planning of interventions related to speaking proficiency development. In most cases, aviation training material is focused on repetition and memorization of information. Troncoso (cited by Paramasivam, 2013) considers that material design needs to consider the material's social, cultural, and educational variables. For Paramasivam (2013), the sociocultural context is crucial for material development, especially the elements related to the learners, in this sense "The social and cultural refer to the who, where, what for, and why of the sociocultural context where the material is used" (p,99). The perspective from English language teaching is also vital in material design; Paramasivam (2013) considers learners' language needs essential in terms of language use before designing materials. Finally, the methodology is also a factor to consider as it provides a frame for activities planning and the material selection or design, according to the activities proposed.

3.9. Assessment in aviation English

ICAO has established the language proficiency requirements (LPRs) to standardize aviation English required communicative competence levels. Alderson (2009) considers the six levels of the LPRs rating scale and the six areas of language use, and the minimum required level of 4 out of 6 considered the operational level. The six areas of language use are pronunciation, structure, vocabulary, fluency, comprehension, and interaction, based on oral communication performance. Test activities vary depending on the provider of the test; however, in general, tests are aimed to validate oral communicative competence in aviation English, focused on nonroutine situations and intercultural communicative competence. The present research aims to conduct an error analysis on ATC aviation English performance; even if the final objective is not to prepare

the participant for the LPRs, understanding the assessment methods and expected competence helps design the intervention strategy aligned with the findings of the error analysis.

3.10. Error analysis

The literature analysis related to aviation English provides a broader view of the context and the elements that require deeper analysis and comprehension during an error analysis research. The different views and perspectives from the authors who boarded the same topic provide a strong frame for the research on the specific field of aviation English. Most of the time, non-native English speakers air traffic controllers, have learned English for aeronautical purposes as the only experience in EFL use; this fact reduces the exposure to plain English. As Rustipa (2011) states: "A key finding of error analysis has been that many learner errors are produced by learners making faulty inferences about the rules of the new language" (p, 18). In this sense, the short time of Interaction in the target language allows to produce such errors.

For the air traffic controllers' context presented above, error analysis is one of the most appropriate resources to identify and propose alternatives to implement error correction. Castillejos (2009) explains the concept by presenting the benefits of error correction in language teaching as a reliable source for teachers to understand what areas of ELT their teaching should focus on. This fact is significant in this study as one of the findings from the needs analysis is an ATCs lack of time for attending EFL courses and the error analysis. In addition to needs analysis, allows to focus the intervention design on specific issues and communicative elements. On the same line, Castillejos states that "by analyzing errors important suggestions for language method design can be made, this involves all the areas of the pedagogical design, from the syllabus to materials" (p, 677). Then, the most specific content and teaching strategies are chosen for the intervention to assure the most improvement on ATCs oral performance.

It is very interesting the perspective of linguists, language teachers, language researchers, and general people who focus their attention on language performance over operational issues. Even though several error analysis studies were consulted, none of them is aimed at the current research interest. I consider this factor an excellent opportunity to make significant inputs in error corrections and provide helpful improvement strategies to ATCs.

4. Research methodology

This proposal was based on an error analysis methodology. This was a qualitative study with a deductive approach focused on observation and English oral performance analysis. The study proposed a sequenced scheme for data collection, using qualitative and quantitative data. The proposed methodology allowed including actual findings in the design of the intervention strategies and adapting them to the changing external factors presented during the research implementation, such as mobility restrictions, health issues, and implementation interactions through virtual environments and informatic communications and technology resources.

4.1. Context

There are 25 certified air traffic controllers (age 19 to 40) providing air traffic services they are settled in Cali and their area of responsibility includes North of Cauca, and Valle del Cauca. They are responsible for traffic control, air traffic information, and search & rescue services for military and civil flight.

Regarding English for aviation teaching, there is a training and retraining program scheduled once a year. The training program is not only for EFL but includes all subjects required for ATC proper performance. The training span is about two weeks, 8 hours per day, including two practical performance tests in actual working conditions. The training program is based on professional ATC personnel knowledge and operational and procedural updates sharing; no external ATC instructors nor EFL teachers are usually considered in this training program.

4.2. Participants

Seven air traffic controllers (*n* 7. Five males and two females) participated in this study. These participants (convenience sample) showed interest in improving their oral performance, attended previous studies at language institutes, and were ranked between primary and intermediate levels (40 and 80 percent) in a test air traffic controllers take once a year (this test is reading and listening based). The seven participants are currently certified to work autonomously (without supervision), and their duties include interacting with pilots using English standard phraseology.

4.3. Data collection

The data collection for this research was divided into three stages due to the current situations, such as mobility restrictions and health issues related to the pandemic emergency generated by COVID 19 pandemic; data collection required the use of ICT resources to implement the following instruments:

1- Online survey (google forms survey) for initial characterization. (See appendix A) Primary data such as age, previous English studies, and expectations on English language learning were collected. Out of 25 controllers, twelve answered.

2- Interviews (zoom meeting) for needs analysis: participants were asked about their expectations and needs with four open-ended questions; simultaneously, the error analysis data collection adjustments were socialized to them. Due to several situations presented in participants' contexts, only seven participants could attend the zoom meetings.

3- Simulated ATC duty (zoom meeting) for error analysis data collection: due to the sensitive content of air traffic control actual recordings and the legal restrictions to access them, the data was collected through simulated ATC duties developed entirely in English. I led simulations following the regular flow of air traffic control duties, where I played the role of English speakers' pilots interacting with the participant air traffic controllers. Due to the current situation, such interactions were performed through virtual zoom meetings. Simulations setting included landing, takeoff, and on-ground operations sequences of planes and helicopters' pilots, the firetruck operator, aircraft identifications, position reports, and ATC facilities names, were the same as in actual participants' context.

These data collection instruments were implemented in sequence according to the research interest and the process advance; several adjustments in form were implemented to fit the current changing situations. Characterization survey and interview questions looked for ATCs' background and training information. The focus of the interview was the training or knowledge in EFL for general purposes and English for aviation. It also included questions aimed to get ATC's perceptions about strengths and difficulties using EFL for aviation (See appendix A). The questions asked to the participants to analyze their needs and expectation on EFL learning were:

1. Do you consider English important to your job? Why?

2. What do you consider are your strengths in the use of English as a foreign language?

3. Do you think that you can improve your proficiency by recognizing errors in the use of the EFL?

4. What aspects would you like to improve in using the EFL in your work as ATC?

In the next stage, direct observation of air traffic controllers' EFL performance was conducted. According to aeronautical regulations, it was impossible to observe real-life operations or access actual ATC recordings. Hence, to maximize EFL use for aviation, the observation was conducted over a simulated duty using only EFL interactions. The observations were conducted for each ATC, including routine and nonroutine situations through the zoom meetings platform. Sessions were recorded and later transcribed for their analysis. Simulations followed the same rules as conventional labor has, looking as realistic as possible to check the ATC's EFL performance in real situations.

Simulations include actual callsigns, phraseology, radiocommunications based on actual ATCs context and geographical scenario; these facts allow participants to use EFL in the same way they commonly do in their duties. In this sense, Castillejos (2009) considered that the communication objective is accomplished when communication takes place with the appropriate structure, register, style, and lexis (p, 678); thus, structured simulations are suitable to replace actual ATC recordings.

Recordings were transcribed, considering and identifying as many errors as possible. When transcriptions were completed, a quantitative analysis focused on each speaker's error frequency and their mode within the group of speakers was developed. At the same time, a qualitative analysis and error taxonomy was conducted considering the relevance and impact of errors in the message transmission and understanding errors' origin. To combine both data sources, a mixed analysis was conducted, including qualitative and quantitative data as the primary input to design a corrective strategy according to the target group's needs and based on the analysis conducted.

Finally, a survey was applied to collect participants' perceptions and determine the intervention impact on their conceptions, thoughts, and in general, if there was a meaningful improvement in EFL performance (See appendix B).

5. Data analysis

The data analysis was addressed to contrast how frequent errors were on ATCs oral performance, and the mode of error observed. First, the frequency was determined by contrasting the total number of ATCs communications with those ones where errors were observed. Participants were exposed to similar simulations using the same aircraft call signs and sequence to keep frequency and error modes data. The total amount of communications was gotten from sum ATCs communications, then, the analysis allowed to identify the ones with errors in oral production. This analysis was strictly statistical and showed the percentage of communications affected by errors in oral performance.

In the same direction, the qualitative analysis was centered on identifying communications containing errors; the goal was to determine the errors' level of grammar and modes. Identifying error modes and their occurrence frequency provided a broad view of the error influence on ATCs oral performance and defined the parameters to be considered in a corrective strategy design aimed to increase ATCs awareness on communication errors.

Graph 1. Data analysis sequence
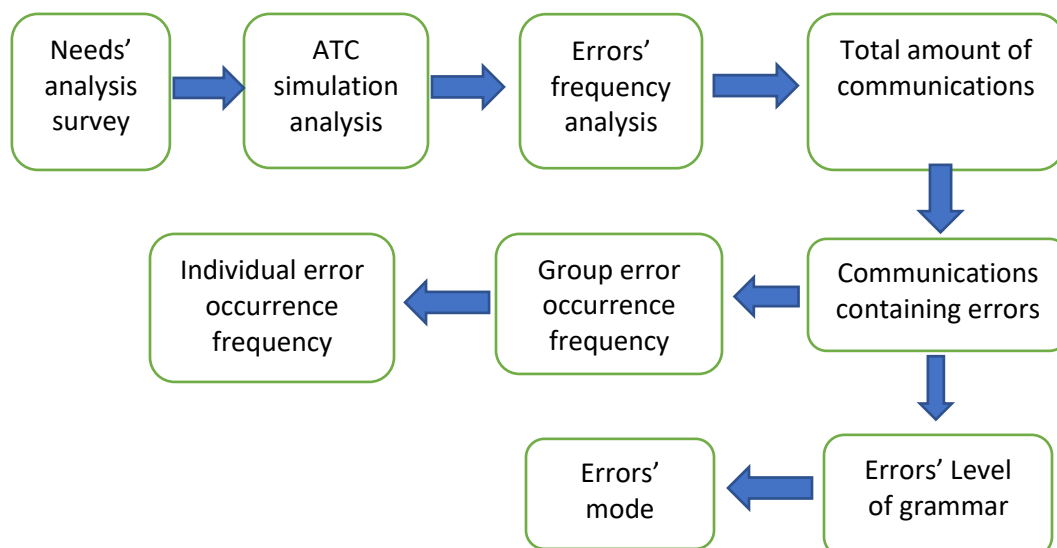
5.1. Results

The information collected was presented as the core of the error analysis conducted. First, the characterization survey results allowed identifying the target group and possible participants in the research. The needs analysis from the interview answers summary allowed me to have a clear idea of participants' needs and expectations about the study, as they expressed their self-perception related to English performance. Next, the results of the error analysis were presented as well as the intervention strategy design. Finally, participants' perceptions and thoughts on the intervention were presented.

5.1.1. Characterization survey

At the beginning of the research, 25 air traffic controllers were convened to participate; however, only 12 of them answered the characterization survey expressing their willingness to participate. In graph 2, we can see how 10 of the initial participants (83%) were in the younger groups under 35 years old.

Select one option according to your age
12 responses

33.3%

16.7%

25%

25%

- 18 to 25
- 25 to 30
- 30 to 35
- more than 35
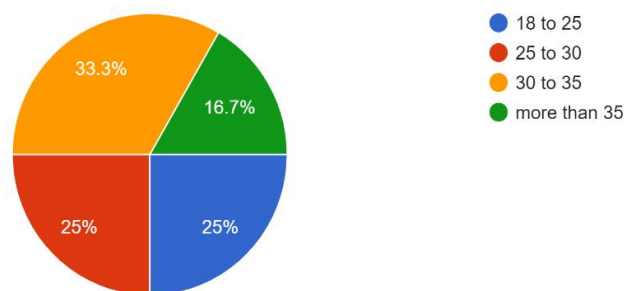
Graph 2: Age range of the participants

In graph 3, we observe a slightly higher percentage of participants that have attended English courses at language institutes; only seven (58.3%) out of 12 have done it. In this sense, it is crucial to identify the reasons for ATC's low access to EFL learning courses to design a meaningful intervention strategy.
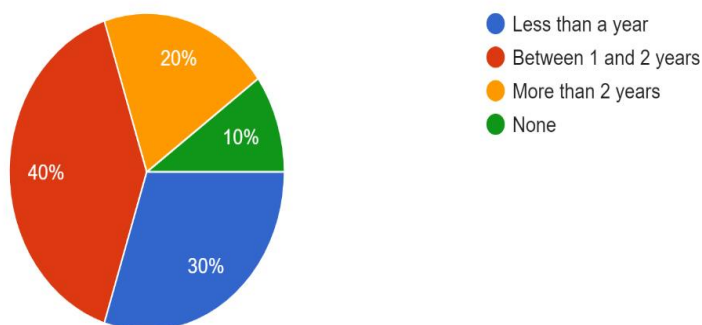
Have you ever studied English as a Foreign Language (EFL) beyond the ATC trainnig program ?
12 responses
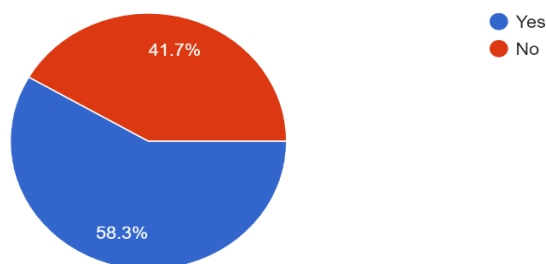
Graph 3: Participants' EFL studies background

Reviewing participants' time of participation in EFL courses presented in graph 4

How long have you studied Enlgish as a foreign language?
10 responses

*Graph 4: Participants' time of EFL study*

Only 10 out of 12 participants answered this question; from this number, 80% of them have invested two years or less studying English, and 10% percent of them do not consider they

have learned EFL. This fact implies that the training on English standard phraseology in ATC training programs is not a significant EFL learning.

Considering the results from the placement test applied to evaluate EFL level (Graph 5), 58,3% of participants scored under 60%, and from this number more than a half; 33.3 % achieved under 40%. This fact reinforced participants' perceptions about their low performance in EFL. This perspective aligns with the previous considerations about access to EFL learning programs. The test was designed to evaluate reading and listening in plain English rather than oral production in aviation English.

According to the last ALCPT you have presented, your score is:
12 responses
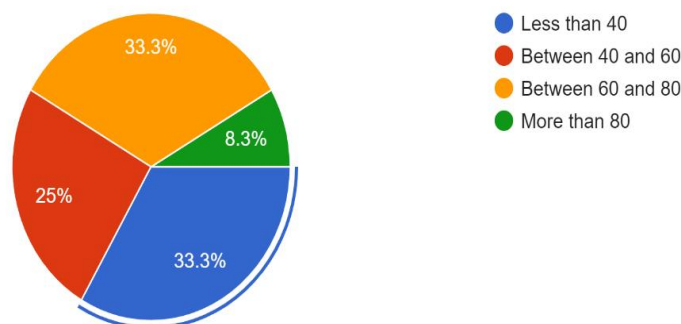
Graph 5: Participants' EFL level

In general, participants considered that their pronunciation, fluency, vocabulary, and comprehension are adequate for their needs. However, most of them would like to improve listening and speaking performance as the most relevant features needed to be more effective in using EFL in their duties and interactions in different contexts like the tests and training programs. (Graph 6)

Which of the following aspects do you consider need to be improved in order to achieve a better EFL performance (you can check more than one)

12 responses
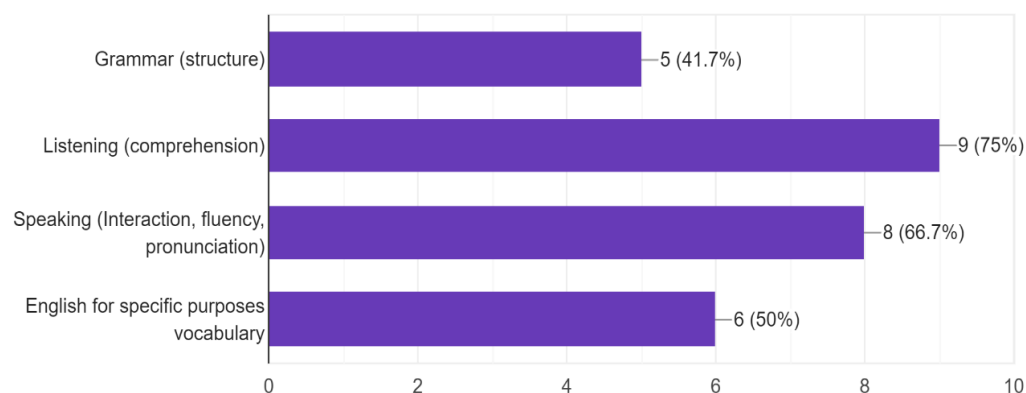
Graph 6: Participants' needs perception

The characterization conducted has shown several facts to be considered in the participants' needs analysis. The first consideration is related to participants' ages; younger ATCs are more interested in participating in EFL learning programs than the older ones. The second fact to consider is ATC's perception about EFL learning processes and their proficiency. In general, they thought that knowing aviation technical English and standard phraseology does not necessarily knowing English; this idea is reinforced by the low scores in the annual placement tests. Finally, participants agreed they need to improve listening and speaking more than the other skills; however, those skills are part of the EFL proficiency and need to be acquired and enhanced to achieve competence.

5.1.2. Needs analysis

After the characterization survey was completed, it was evident an issue related to participants' time availability. Even though 12 air traffic controllers agreed to start the process, five had to resign due to time availability and several situations related to their job. The

conditions were derived from public order situations and other personal issues. The seven remaining participants were interviewed to add meaningful information to the needs analysis; these interviews were performed through Zoom meetings platform due to the pandemic emergency still present in the local context.

Interview questions sought for a clearer view of participants' thoughts and expectations about the EFL learning process focused on aviation English performance. I observed the lack of confidence using EFL: air traffic controllers preferred to answer the interview question in Spanish as they did not feel confident expressing their ideas in English. Despite their lack of confidence, it was evident they have an adequate domain of standard English phraseology and a solid basis in plain English. However, the lack of a context to use English beyond the air traffic control field affects their confidence and general English performance.

The first question aimed to determine participants' awareness about EFL importance for their job as air traffic controllers. In this sense, they all agreed that English was necessary for their job as air traffic controllers; English is key to providing air traffic services safely and precisely. The following was expressed by a male, age 26, controller:

"… I consider that English must be learned to be able to make correct decisions in our environment since due to these errors of understanding and issuance of instructions, tragedies, and events to be regretted have been generated in world aviation. English should be something natural and necessary for us as air traffic controllers[2]."

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[2] Authors' own translation.

Their main concern about EFL use is related to emergency and nonroutine situations where standard phraseology is insufficient to communicate effectively. The following was expressed by a male, age 23, controller:

"En la parte del control el inglés es el idioma universal, en la parte de aviación, hay una fraseología, pero debemos acercarnos también a una comunicación no rutinaria ya que hay más situaciones como las situaciones de emergencia y requerimientos como los del personal de tierra entonces uno debe estar sujeto a esa necesidad de la parte del inglés".

"In the control part, English is the universal language, in the aviation part, there is a phraseology, but we must also approach to a nonroutine communication since there are more situations such as emergencies and requirements like those of ground personnel, so, one must be subject to that need on the part of English."

Traffic controllers' perceptions reveal how aware they were about the importance of being proficient in English for aviation as a critical element for their job. They also consider essential to improve their proficiency in plain English to deal with emergency and abnormal situations not considered in standard phraseology.

The second question inquired about air traffic controllers' EFL performance self-perception. In this sense, most participants consider their fluency and listening related to aviation English as their biggest strength; nevertheless, they felt unconfident expressing or understanding non-standard messages. The following was told by a male, age 30, controller:

"…siento que cuando el piloto se sale de la fraseología normalizada con términos que no conozco, generalmente los entiendo, pero me es difícil hacerme entender solamente con la fraseología".

"…I feel that when the pilot goes outside the standard phraseology with terms that I do not know, I generally understand them, but it is difficult for me to make myself understood with the phraseology alone".

Air traffic controllers felt that standard phraseology is not enough to face their job; they consider unusual or nonroutine situations the most challenging in EFL use; on the same line, they believe it more difficult to produce coherent and structured messages than understanding nonroutine communications.

The third question aimed to determine their perception about corrective strategies was based on errors in EFL awareness. Participants found relevant and appropriate an external person analyzing their errors as an effective strategy for improvement. The following was expressed by a male, age 19, controller:

"Yo creo que sí, porque generalmente es muy difícil para uno darse cuenta de sus propios errores, porque muchas veces uno piensa que está pronunciando bien y siempre debe haber alguien que analice usted como está hablando o está usando el lenguaje para que le ayude a analizar las falencias que uno puede tener y que se vuelven parte como de uno mismo".

"I think so because generally, it is very difficult for one to realize one's own mistakes because many times you think that you are pronouncing well, and there should always be someone who analyzes how you are speaking or using language to help you analyze the shortcomings that one may have and that becomes part of oneself."

Participants believe that an expert must indicate corrections after analyzing their performance. They do not consider they can make self-corrections effectively as they don't

consider themselves fully proficient in EFL. On the other hand, they accept the corrections made from external observers as they were trained to acquire the skills by copying and repeating the facts they consider appropriate and valuable for their job.

Finally, the last question delved deeper into the understanding of their expectations and interests in EFL learning. In this sense, participants want to improve their speaking and listening skills as they previously stated in the survey; however, their interests are related to learning about structure, pronunciation, grammar, vocabulary, and in general, a broader knowledge about EFL, allowing them to increase their communicative competence in plain and aviation English situations. The following was expressed by a female, age 26, controller:

> "Me gustaría mejorar a la hora de dar instrucciones adicionales o hacer preguntas, preguntas que se salen de la fraseología y requieren inglés conversacional".

> "I would like to improve when it comes to giving additional instructions or asking questions, questions that go beyond the phraseology and require conversational English."

> "Me gustaría mejorar la fluidez, a veces siento que puedo tener el conocimiento de muchas cosas, pero me considero ignorante en la estructura, cómo se deben armar las oraciones, las reglas que muchas veces desconozco hasta en español…"

> "I would like to improve fluency, sometimes I feel that I can know many things, but I consider myself ignorant in the structure, how sentences should be built, the rules that many times I do not know even in Spanish ..."

The analysis of the interviews allowed me to have a clear and more precise understanding of air traffic controllers' needs. This analysis provides a solid starting point for the error analysis on ATCs oral performance and the posterior corrective intervention strategy design.

In conclusion, air traffic controllers recognized the importance of English proficiency for their jobs; they also were aware that their performance needs to be improved, mainly in nonroutine situations repertoire and oral production. In the same direction, they considered error analysis and valuable feedback for their performance improvement. They were not fully aware of their errors, mainly in basic English structure and vocabulary. To summarize, ATCs considered it essential to attend English classes focused on their needs and specific situations vocabulary and structure; in this sense, needs' analysis could be an essential source of information for intervention strategy design.

5.1.3. Error analysis

This research includes the analysis of seven recordings from the same number of participants. The analysis was based on air traffic control interactions recordings; however, as air traffic control facilities are restricted places, and actual recordings belong to the custody chain in legal investigations, it was impossible to access actual ATC recordings. Then, the analysis was conducted on simulated communications where I performed the role of the pilots calling ATC facilities, and the participants performed their roles as air traffic controllers. Simulations allow performing all the communications in English, increasing the language use and interactions in the target language, and including routine and nonroutine situations creating a broader context for EFL use. Participants were exposed to similar situations, including the same aircraft call signs and sequence; this strategy helped determine the frequency of error and the type of errors in the same specific communicative situation, something challenging to achieve in actual ATC duties.

Errors found were classified according to the four levels of grammar proposed in Gibson et al. (2006) communication error taxonomy: phonetic, semantic, syntactic, and pragmatical

errors. In this sense, communication error emerges from the correlation among communication

failures, deviations from the grammar, and task communication errors (p, 58). In addition, errors

were classified according to error modes observed (See table 1).

Table 1. Level of grammar and error mode occurrence frequency

Level of grammar	Error mode	Total samples	Errors	Total errors	Percentage
Phonetic 41,8%	Omitting sounds		13		5,3%
	Changing vowel sounds		13		5,3%
	Adding vowel sounds		4		1,6%
	Changing consonant sounds		5		2,1%
	Switching word stress		1		0,4%
Semantic 25,6%	Pronunciation could affect meaning	244	6	86 (35,2%)	2,4%
	Word order could affect the meaning		1		0,4%
	Vocabulary		15		6,1%
Syntax 26,7%	Word order		14		5,7%
	Structure		9		3,7%
Pragmatic 5,8%	Use of non-standard expressions		5		2,1%

According to the grammar level, errors' classification showed that most of the errors

observed in ATCs performance were related to the phonetic level; 41,8% of errors observed

belong to this classification. Semantic with 25,6 % and syntactic with 26,7 % errors represented

each one around a quarter of errors observed, contrasting with a discrete 5,8 % of pragmatic

errors. This analysis allowed us to determine that the most common errors belonged to the

production of sounds in English; despite their high frequency, such errors barely affect the

meaning of messages and do not block or interfere with communication intention. Errors that

could affect the meaning are about vocabulary, and structure issues were less common but in

perspective require more attention than the phonetical ones since they can affect the meaning of

the messages leading to misunderstandings and aviation safety risks. Pragmatic errors were

barely observed and centered on transferring cultural elements from Spanish and conventional

English to aeronautical English.

As transcriptions include both interactions from the pseudo-pilot and participants, the

errors frequency analysis only considered messages from the participants; on the same line,

errors' frequency were also analyzed by the number of errors belonging from each participant.

(See table 2)

Table 2 Individual error occurrence frequency

Participant	Communications	Number of errors	Percentage
1	40	11	27,5%
2	47	19	40,4%
3	34	5	14,7%
4	32	9	28.1%
5	44	13	29,5%
6	47	15	31,9%
7	36	14	38,9%

Frequency analysis showed that 35,2% of communications (messages) contained errors;

however, the average percentage after analyzing individual error taxonomy represents a lower

percentage, only 28,1%. These results showed us that errors are present in most of the

communication between pilots and ATCs; at least a fourth part of communications could be

affected by errors in oral interactions. On the same line, the analysis shows that the most

common errors were related to vocabulary 6,1%, word order 5,7%, pronunciation omitting

sounds and changing vowel sounds, 5,1% each. Individual analysis showed that errors average

was 12. The highest number of errors was 19 out of 47 communications representing 40,4%. The

minimum number of errors was 5 out of 34, representing 14,7 % of the participant

communications. The errors frequency showed a light tendency to perform errors; most of them do not significantly affect the communicative competence of the group members.

These data provide a clear and precise view of ATCs needs in current EFL use, giving a solid basis to design and implement an intervention that allows ATCs to identify errors present in their daily radiocommunications and, simultaneously, develop self and peer correction strategies as a critical element in communicative ability improvement.

Even though the frequency analysis identifies the number and types of errors, errors, errors do not necessarily affect message intention: ATCs usually train among themselves and copy the performance from their partners in English for aviation. Thus, the transmission of errors could eventually become a linguistic variation challenging to understand, primarily through radiocommunications equipment used for ATC pilots' interactions.

In a qualitative analysis, errors can be related to single elements correlated in error criteria definition presented by Gibson et al. (2006); in this sense, semantic errors found in the analysis could be linked to communication failures as they usually generate additional communications looking for better comprehension of the message.

Syntactic errors and some of the semantic ones observed can be linked to deviations from the grammar as they are not aligned with the standard language required in aeronautical contexts. Finally, phonetic and pragmatic errors show task communication errors performed during the use of English for practical purposes.

Some examples of the findings in the qualitative analysis are presented in Table 3

Table 3. Error qualitative analysis

Error	Utterance	Analysis
Sound omission: a word or a part of it is omitted.	"Colombian Air Force two four two nine wind clam cleared for *take o*" /teɪk o/ "Roger Spark 61 runway use two five."	The participant omitted the final "f" sound, in the expression "take off."/teɪk ɔf/ The participant omitted the word "in" /ɪn/, in the expression "Runway in use" /rʌnˌweɪ ɪn juz/ This type of error does not affect meaning.
Changing vowel sound.	"…ronway /ronˌweɪ/ in use two five"	The participant changed /ʌ/ sounds in runway to /o/ This type of errors does not affect meaning.
Switch word stress.	"That's correct"	Participant stressed the word "correct" in the syllable /kə/ This type of errors does not affect meaning.
Pronunciation could affect meaning	"Spark 61 ground 1518 vacated runway via Charlie taxiway"	Participant pronounced the verb "vacated" /veɪˈkeɪtəd / instead of vacate /veɪkeɪt/ it is not clear if this is an instruction or a report This type of errors affects meaning.
Word order could affect meaning.	"Spark 61 ... via Charlie taxiway report vacate runway"	The participant changed word order in the expression "report vacate runway" the correct expression is the position report "runway vacated" it is not clear if this is an instruction or a report This type of errors affects meaning.
Vocabulary	"Arpía taxi to holding point Charlie hold short of and stand by instructions"	The participant used the expression "hold short of" instead of "hold short of runway"

		This type of errors affects meaning.
Word order	"UL 337 make hold visual over Juanchito …"	Participants wrong use of adjectives before nouns: "hold visual" instead of "visual hold" This type of errors affects meaning.
Structure	"Arpía… do you ready for present position for departure?"	The participant used inadequate questioning structure. (yes/no questions) This type of errors affects meaning.
Use of non-standard expressions	"...excuse me Arpía squawk 7377"	The participant used "excuse me" This is not an accepted expression in aeronautical English; "correction" must be used instead
	"Rider 03 sequence landing two"	The participant used the expression sequence landing to replace "number two to land" The use of non-standard expression affects meaning specially for NNESs using Aeronautical English.

5.2. Intervention design

Considering the information acquired through error analysis, complemented by the needs' analysis perspective from participants' interviews, I have designed an intervention plan focused on improving EFL oral performance and developing self and peer correction strategies. Thus, the intervention aims to increase participants' awareness of EFL and the ability to identify and correct errors in their oral performance and their partners'.

The course was designed to be developed in 20 hours, 10 hours in virtual synchronic meetings, and 10 hours in autonomous work from students. Each unit was developed in a 2-hour synchronic meeting with additional tasks developed before and after the meeting (See appendix C). The intervention also included the implementation of informatics and communications technology (ICT) (See appendix D). The methodology was based on a communicative approach as the needs' analysis reflected participants' need for oral Interaction and effective communications. According to the level of knowledge and learning in every unit, task-based learning (TBL), content and language and integrated learning (CLIL), and Problem-solving based learning (PBL) were implemented to conduct the intervention according to participants' expectations. (See table 4)

The name of the intervention was "English as a Foreign Language Air Traffic Controllers Training Program," it had two main goals: To perform effective communications in aeronautical English and increase awareness about EFL / ELF use in aeronautical context. On the same line, the learning objectives were: To identify aeronautical English vocabulary commonly used in ATC routine and nonroutine communications, to recognize grammatical elements used in ATC communications, to perform effective communications using aeronautical English expressions, to use IPA as a guide to improve pronunciation and comprehension; to develop self-awareness about EFL / ELF errors and corrective strategies implementation; and to incorporate self-correction strategies as a typical ATC work and training activity.

Interventions were conducted through the Zoom meetings platform in two-hour synchronous interactions per unit and from 2 to 4 hours of asynchronous autonomous work (See appendix D). Participants were introduced to pronunciation practice applications based on ICT to allow autonomous pronunciation and practice of the phonological techniques and standard

English sounds. Content and vocabulary were focused on their actual aeronautical work context, complemented with videos and case studies based on actual pilots-ATCs interactions. EFL awareness was approached from the perspective of non-native English speakers' cultural dimensions and communicative resources as well as strategies to communicate effectively using EFL or English as a lingua franca (ELF) in aeronautical routine and nonroutine situations.

Table 4. Intervention curriculum contents

Unit 1: Why aeronautical English?

Associated knowledge	Topics	Materials
Vocabulary related to routine and nonroutine aeronautical communications	a) Common aeronautical expressions b) Standard phraseology review c) Routine expressions d) nonroutine expressions e) Aeronautical vocabulary documents f) True and false cognates	M1) Aeronautical glossary worksheet M2) Multimedia resources M3) Audiovisual resources
Pronunciation of aeronautical phraseology common expressions	a) Error correction based on error analysis findings b) Common errors in EFL / ELF pronunciation c) IPA basic d) Intonation stress and communication flow e) Understanding the relationship between speaking and comprehension	M1) Multimedia resources M2) Audiovisual resources M3) worksheets
To give coherent and easily understandable commands according to English aeronautical requirements	a) English commands' structure b) Common phrasal verbs used in aeronautical context c) Prepositions of place and time	M1) Practical workshops M2) Online Activities M3) Audiovisual resources
To communicate effectively in aeronautical English in routine and nonroutine situations	a) Turn-taking in oral aeronautical interactions b) Negotiation of meaning in nonroutine situations	M1) Online resources M2) Audiovisual resources M3) Practical workshops

To develop awareness about EFL / ELF use in aeronautical routine and non -routine contexts	a) English variations b) ICC and ELF concepts awareness	M1) Audiovisual resources

Unit 2: Improving my speaking

Grammatical rules of English related to give instructions and ask for information in aeronautical operations context.	a) Simple present, simple past, simple future review b) Questioning in simple tenses Y/N and WH questions c) Pronunciation tips for regular verbs in simple past d) Prepositions e) imperatives	M1) Aeronautical glossary worksheet M2) Multimedia resources M3) Audiovisual resources
Word order of importance in English speaking	a) Adjectives before nouns in airport facilities names b) Word order to express possession d) Word order in aff. Neg. and questions e) Word order and imperatives	M1) Multimedia resources M2) Audiovisual resources M3) worksheets
Basic phonetic rules and IPA use basis.	a) Production of English sounds b) Understanding basic differences between Spanish and English sounds c) IPA general use and basic knowledge	M1) Practical workshops M2) Online Activities M3) Audiovisual resources
To communicate effectively in aeronautical English in routine and nonroutine situations	a) Common emergencies vocabulary b) Recognizing English sounds in aeronautical communications	M1) Online resources M2) Audiovisual resources M3) Practical workshops
To use IPA as a guide to improving English pronunciation and comprehension	a) IPA general use and basic knowledge (practice)	M1) Online resources M2) pronunciation App

Unit 3: Using IPA to check the pronunciation

Basic phonetic rules and IPA use basis.	a) Basic Vowel phonetics sounds b) Basic consonants Phonetics sounds c) Specific sounds for aeronautical English d) Differences between Spanish and English sounds II	M1) Aeronautical glossary worksheet M2) Multimedia resources M3) Audiovisual resources

To give coherent and easily understandable commands according to English aeronautical requirements	a) Produce commands in English using IPA to improve pronunciation b) Include new and pertinent vocabulary to improve commands and instructions	M1) Multimedia resources M2) Audiovisual resources M3) worksheets
To communicate effectively in aeronautical English in routine and nonroutine situations	a) Identifying and understanding English sounds from aeronautical communications based on IPA knowledge b) Checking errors from error analysis based on IPA and improve their pronunciation.	M1) Practical workshops M2) Online Activities M3) Audiovisual resources
To use IPA as a guide to improving English pronunciation and comprehension	a) Identifying and understanding English sounds from aeronautical communications based on IPA knowledge b) Checking errors from error analysis based on IPA and improve their pronunciation.	M1) Online resources M2) Audiovisual resources M3) Practical workshops
To develop awareness about EFL / ELF use in aeronautical routine and non -routine contexts	a) Analyze aeronautical English communications and improve listening from IPA implementation	M1) Online resources M2) pronunciation App

Unit 4: ICT tools implementation for pronunciation improvement

Pronunciation of aeronautical phraseology common expressions	a) Aeronautical phraseology common expressions IPA analysis and pronunciation improvement b) ICAO's radiotelephony Phonetic alphabet correct pronunciation	M1) Aeronautical glossary worksheet M2) Multimedia resources M3) Audiovisual resources
Basic phonetic rules and IPA use basis.	a) IPA as a guide to check aeronautical expressions pronunciation b) Vowel phonetics sounds II c) Consonant's phonetics sounds II	M1) Multimedia resources M2) Audiovisual resources M3) worksheets
To communicate effectively in aeronautical English in routine and nonroutine situations	a) Common English sounds articulation Check (App)	M1) Practical workshops M2) Pronunciation app M3) Audiovisual resources

To use IPA as a guide to improving English pronunciation and comprehension	a) Check the aeronautical glossary and use IPA transcriptions to practice pronunciation	M1) Online resources M2) Audiovisual resources M3) Practical workshops
To incorporate self-correction strategies as a common practice in ATC work and training duties.	a) How language variations affect aeronautical English expressions pronunciation	M1) Online resources M2) pronunciation app

Unit 5: Checking my progress

To understand oral communications in aeronautical English	a) Check understanding by using routine and nonroutine communications from certification tests samples	M1) Aeronautical glossary worksheet M2) Multimedia resources M3) Audiovisual resources
To communicate effectively in aeronautical English in routine and nonroutine situations	a) English for aviation certification test (TEA, EALTS) generalities and minimum requirements	M1) Multimedia resources M2) Audiovisual resources
To use IPA as a guide to improve English pronunciation and comprehension	a) Analyze certification tests' samples using IPA to increase comprehension and oral Interaction	M1) Practical workshops M2) Pronunciation app M3) Audiovisual resources
To develop awareness about EFL / ELF use in aeronautical routine and non -routine contexts	a) How aware am I about my performance in EFL / ELF, and what can I do to improve it by myself	M1) Online resources M2) Audiovisual resources M3) Practical workshops
To incorporate self-correction strategies as a common practice in ATC work and training duties.	a) Self and peer correction techniques implementation and communicative competence assessment	M1) Online resources M2) pronunciation app

In Graphs 7, there is one of the examples used to practice IPA with participants; some

expressions are used during the simulations presented with the IPA. At first, students felt

confused with IPA symbols; however, they started to use them to pronounce and realize the

standard pronunciation of the words they commonly used. One of their first perceptions was that the IPA sounds were incorrect; however, they quickly accepted that IPA showed the standard phonetics. They can improve their oral performance by including those sounds in their repertoire. The sentences were:

-"Marco Fidel, good morning, November two three five Zulu (N235Z) go ahead."

-"Check landing gear down and locked."

- "Colombian Air Force"

Graph 7: Sample of using IPA for oral performance improvement

After the initial exposure participants started looking for commonly mispronounced words like calm /kɑm/, air /ɛr/ expressing awareness development on EFL use. A female participant aged 26 commented:

"Me acabo de dar Cuenta que he pronunciado mal la palabra "calm" toda mi vida"

" I've just realized I have mispronounced the word "calm" during my whole life so far."

Although the participants were highly motivated, due to the lack of time and social situation in Cali those days, it was so challenging to implement the classes; in several cases, the class had to be reprogramed or suspended. Considering this fact, the intervention impact was assessed by collecting participants' perceptions about their errors and new knowledge acquired during the intervention. While the interventions were developed, I could observe that participants' perceptions about English changed after each intervention; it was interesting seeing their reactions after realized the standard pronunciation of the words they have used for a long time on their duties. These words were so meaningful as the participant cited before, considered IPA as an effective and helpful tool to determine the correct sound production and an autonomous learning resource, so convenient for her reduced study time availability.

Participants' performance improved slowly, and the errors observed at the beginning of the intervention were eventually replaced by mistakes easily corrected by themselves. Participants' perceptions reflected a more structured understanding of communicative goals, and they started to include other linguistic elements such as code-switching.

5.3. Intervention results

By the end of the intervention, a survey was applied. Results showed participants' perceptions and thoughts about their performance on EFL. In this sense, it is necessary to analyze the results separately to get a clear and precise view of the participants' opinions.

The first question asked participants about their participation in all the activities proposed. Although the meetings were recorded and participants had about a week, some could

not attend the whole course. This fact was analyzed in the initial characterization and

corresponded to the lack of time openly expressed by some of them since the beginning of the

interventions. (See graph 8)

How many classes have you attended? (Includes if you have accessed the recordings)
7 responses
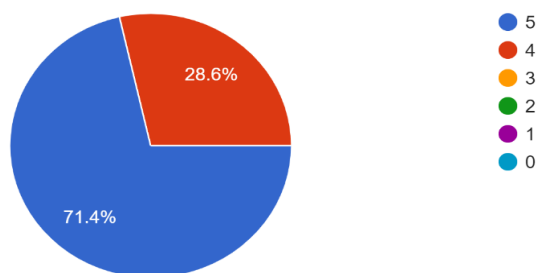
Graph 8: participants' intervention attendance

The second question aimed to determine the most attractive or exciting topic for them;

most of them agreed on pronunciation improvement strategies and communicative strategies

topics as the most relevant and interesting for them. (See graph 9)

What are the most important topics you've seen in the classes ? (you can pick more than one)
7 responses
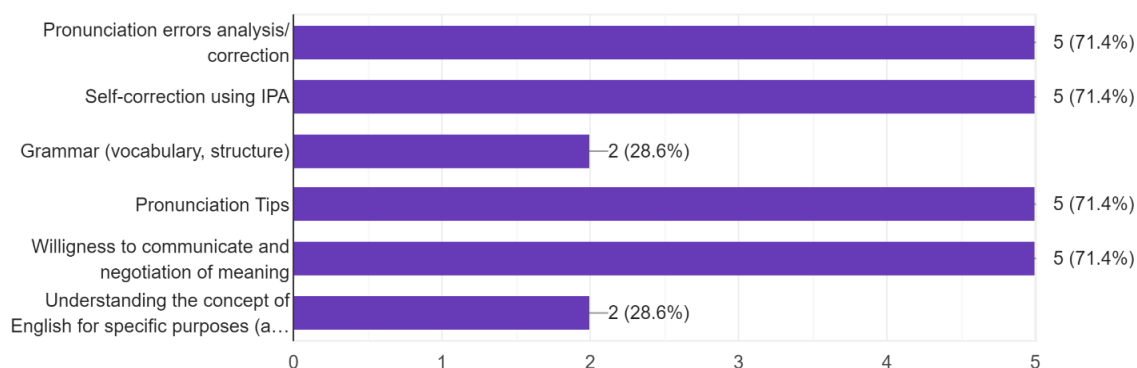
Graph 9: Participants 'perception about topics´ importance

The next question was addressed to get information about the skills they consider to be improved during the Interaction; in this case, the oral interaction skills prevailed over reading and writing, but speaking was the highest score. (See graph 10)

Which of the four skills do you consider have been improved after the classes (you can pick more than one)
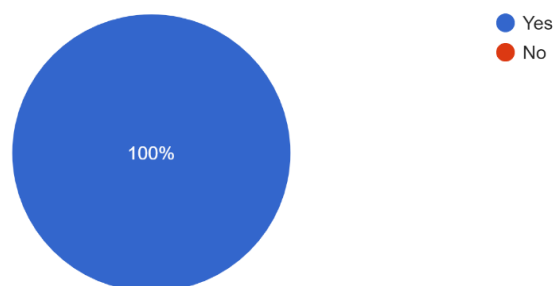7 responses

Reading	—0 (0%)
Speaking	—7 (100%)
Listening	—6 (85.7%)
Writing	—0 (0%)
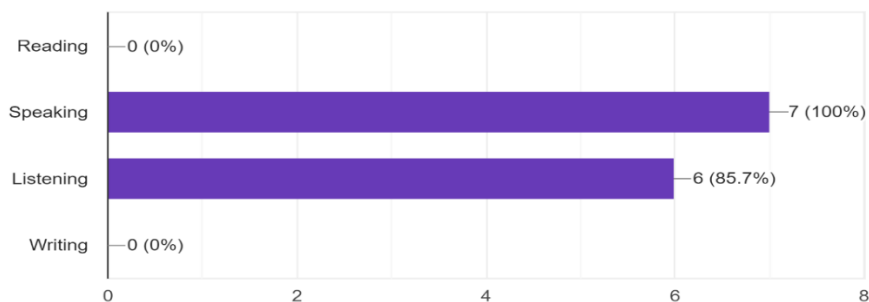
Graph 10: Participants' EFL improvement perception

In the following question, all the participants felt they can now effectively conduct self and peer corrections (Graph 11). At the same time, they consider that by learning pronunciation strategies, they have improved their comprehension. (See graph 12)

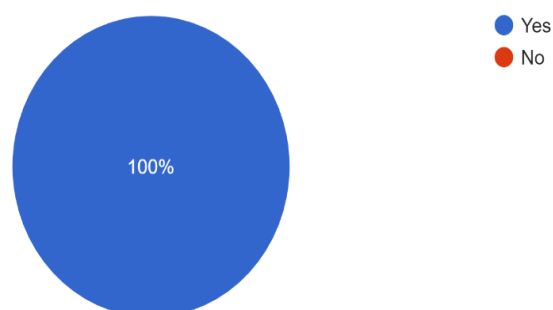After the intervention, do you consider you are able to make self and peer corrections?
7 responses

● Yes
● No

100%

Graph 11: Participants' perceptions about self and peer corrections ability

In your opinion, are the pronunciation tips helpful to improve your comprehension?
7 responses

● Yes
● No

100%

Graph 12: Participants perceptions about pronunciation tips usefulness

Three more questions were asked to them to have a better understanding of their thoughts. The first one was aimed to get their perception about their performance in EFL. The question was, "In your opinion, is it possible for you as a non-native English speaker to be effective in the use of English? Please explain your position". One of the most relevant answers was provided by a female participant aged 26:

"It is important to be effective, understand, and make me understand on the frequency with all the crew who flies in Guabito."

The word "Guabito" is the identification for ATC area of responsibility; this question shows how the content and skills acquired in the intervention are closely linked to participants context as they think of applying new knowledge to their work context. At the same time, the message expresses the intention to communicate and the desire to be functional and practical over being native-like EFL speakers.

The next question was addressed to get participants' perceptions about IPA use as a tool for oral interaction improvement; the question was: "Do you think IPA (international phonetical

alphabet) is a helpful tool in your English learning process? Why? Two answers called my attention. As mentioned by a male, age 27, participant:

"Yes, because I improve the pronunciation and understand the different words."

In this sentence, the participant expresses how learning sounds correct production and articulation helps him better comprehend English sounds. On the same line, the following answer shows the level of awareness developed as they understand that English and Spanish sounds are different; thus, they need to start producing and understanding correct sounds according to their language. This male participant, age 30, answered:

"Yes, it allows us to produce standard English sounds that we are not familiar with as they do not belong to the Spanish language."

Finally, they were asked about their global perception of the intervention; the results are presented in graph12.

In general, do you consider the error analysis and intervention strategy implemented were:
7 responses

- Relevant and useful
- Relevant but useless
- Not appropriated (out of context)

100%
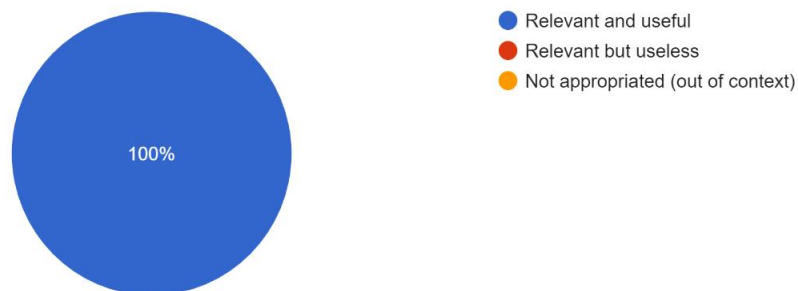
Graph 12: Participants' perception about EA intervention

Participants agreed that the intervention was relevant and provided them valuable resources for their EFL performance improvement.

6. Conclusions

At the beginning of the research, air traffic controllers were aware of the importance of English in their working contexts; however, traditional EFL courses did not fit their needs nor expectations. Due to the characteristics of air traffic control duties, air traffic controllers did not have enough time nor availability to attend formal English courses.

Aviation English vocabulary and grammar learning is based on standard expressions, repetition, and memorization; on the same line, aviation English communicative competence is based on copying models from experienced controllers who have learned EFL in the same way. Air traffic controllers' EFL needs are related to oral interaction skills (listening and speaking). The specificity of the aviation English register demands specific vocabulary and expressions according to the local context. In this sense, air traffic control instructors need to be trained on using aviation English effectively in radiocommunications, providing a suitable model for ATC trainees.

Error analysis methodology provides a clear view of learners' EFL needs, focusing on actual needs improving teaching session design and effectiveness. The frequency analysis focused on error frequency reflects the impact of the number of error messages and how this increases misunderstandings risk directly. Class planning based on error analysis findings is more effective and precise as it focuses learner and teacher attention on specific issues and learners' needs. Learners feel more engaged with courses based on their needs and expectations; error analysis also motivates them to improve their performance by learning corrective strategies.

Awareness of EFL characteristics and cultural and intercultural facts present in aviation English increases learners' motivation to use EFL for communicative purposes. In the same direction, self-correction strategies and resources like IPA for pronunciation correction increase learners' confidence and motivation to communicate.

Error analysis on ATC English performance is an effective strategy to identify learners' needs in specific topics and situations susceptible to being improved. Thus, in the specific case of ATCs context, the error analysis technique is an effective tool for developing ATCs awareness of their strengths and weaknesses, allowing an EFL self-improvement process. ATCs need to develop self and peer correction strategies to provide a more standard and effective model capable of sharing communicative skills with their partners. After the intervention, participants' perceptions showed that they feel more confident about using EFL in their duties and correct their pronunciation by implementing IPA and phonology techniques.

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8. Appendixes

Appendix A

Air Traffic Controllers characterization

This forms aims to collect relevant data in order to conduct a research on the performance of English for aviation on Air Traffic Controllers. The information gathered will be strictly used for academic porpuses.
* Required

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1. Surname and name *

   _____

2. Please write your e-mail

   _____

3. Please write your phone number

   _____

4. Select one option according to your age *

   Mark only one oval.

   ( ) 18 to 25
   ( ) 25 to 30
   ( ) 30 to 35
   ( ) more than 35

5. Have you ever studied English as a Foreign Language (EFL) beyond the ATC trainnig program ? *

Mark only one oval.

◯ Yes

◯ No

◯ Other: _____

6. If the previous answer was YES, please select the institution where you have studied EFL *

Mark only one oval.

◯ Language institute/program abroad

◯ Personal instructor/autonomous learning

◯ EFL institute/program in Colombia (please write the name in other)

◯ Other: _____

7. How long have you studied Enlgish as a foreign language?

Mark only one oval.

◯ Less than a year

◯ Between 1 and 2 years

◯ More than 2 years

◯ Other: _____

8. According to the last ALCPT you have presented, your score is:

Mark only one oval.

◯ Less than 40

◯ Between 40 and 60

◯ Between 60 and 80

◯ More than 80

9. According to your perception, grade your proficiency on EFL pronunciation *

Mark only one oval.

	1	2	3	4	5	
Barely proficient	◯	◯	◯	◯	◯	Fully proficient

10. According to your perception, grade your proficiency on EFL Fluency *

Mark only one oval.

	1	2	3	4	5	
Barely proficient	◯	◯	◯	◯	◯	Fully proficient

11. According to your perception, grade your proficiency on EFL Vocabulary *

Mark only one oval.

	1	2	3	4	5	
Barely proficient	◯	◯	◯	◯	◯	Fully proficient

12. According to your perception, grade your proficiency on EFL Comprehension *

Mark only one oval.

	1	2	3	4	5	
Barely proficient	◯	◯	◯	◯	◯	Fully proficient

13. Which of the following aspects do you consider need to be improved in order to achieve a better EFL performance (you can check more than one) *

Check all that apply.

☐ Grammar (structure)
☐ Listening (comprehension)
☐ Speaking (Interaction, fluency, pronunciation)
☐ English for specific purposes vocabulary
Other: ☐ _____

14. If you consider there is another aspect related to your EFL performance that you need to improve, please write it down

_____

_____

_____

_____

_____

Appendix B

Air Traffic Controllers intervention's feedback

This form is adressed to assess the intervention's impact on ATC English performance. Your answers and inputs are strictly confidential and will be used for academic purposes only.

* Required

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ICESI

1. Please write your full name *

   _____

2. How many classes have you attended? (Includes if you have accessed the recordings) *

   Mark only one oval.

   ⬭ 5

   ⬭ 4

   ⬭ 3

   ⬭ 2

   ⬭ 1

   ⬭ 0

3. What are the most important topics you've seen in the classes ? (you can pick more than one) *

    Check all that apply.

    ☐ Pronunciation errors analysis/correction
    ☐ Self-correction using IPA
    ☐ Grammar (vocabulary, structure)
    ☐ Pronunciation Tips
    ☐ Willigness to communicate and negotiation of meaning
    ☐ Understanding the concept of English for specific purposes (aeronautical English)
    Other: ☐ _____

4. Which of the four skills do you consider have been improved after the classes (you can pick more than one) *

    Check all that apply.

    ☐ Reading
    ☐ Speaking
    ☐ Listening
    ☐ Writing

5. After the intervention, do you consider you are able to make self and peer corrections? *

    Mark only one oval.

    ◯ Yes
    ◯ No

6. In your opinion, are the pronunciation tips helpful to improve your comprehension? *

    Mark only one oval.

    ◯ Yes

    ◯ No

7. In your opinion, Is it possible for you as a non-native English speaker, to be effective in the use of English? Please explain your position. *

    _____

    _____

    _____

    _____

    _____

8. Do you think IPA (international phonetical alphabet) is a usefull tool in your English learning process? Why? *

    _____

    _____

    _____

    _____

    _____

9. Do you consider the pronunciation tips and self correction strategy could help you to face a certification test (EALTS / TEA) ? Why? *

    _____

    _____

    _____

    _____

    _____

10. In general, do you consider the error analysis and intervention strategy implemented were: *

Mark only one oval.

◯ Relevant and useful

◯ Relevant but useless

◯ Not appropriated (out of context)

◯ Other: _____

Appendix C

Intervention strategy curriculum design

Program name
English as a foreign language air traffic controllers training program

Competences (Objectives):
Perform effective communications in aeronautical English / Increase awareness about EFL / ELF use in aeronautical context

	Saber conocer (to Know)
SC1	Vocabulary related to routine and non-routine aeronuatical communications
SC2	Pronunciation of aeronautical phraseology common expressions
SC3	Grammatical rules of English related to give instructions and ask for information in aeronautical operations context.
SC4	Word order importance in English speaking
SC5	Basic phonetic rules and IPA use basis.
SC6	

	Saber hacer (to do)
SH1	To give coherent and easily understandable commands according to aeronautical English requirements
SH2	To understand oral communications in aeronautical Englsih
SH3	To communicate effectively in aeronautical English in routine and non-routine situations
SH4	To use IPA as a guide to improve English pronunciation and comprehension
SH5	
SH6	

	Saber ser (to be)
SS1	To develop awareness about EFL / ELF use in aeronautical routine and non -routiine contexts
SS2	To incorporate self correction strategies as a common practice in ATC work and training duties.
SS3	
SS4	
SS5	
SS6	

The course has been designed to be developed in 20 hours, 10 hours in virtual synchronic meetings and 10 hours in autonomous work from students, each unit will be developed in a 2 hours synchronic meeting with additional tasks to be developed before and after the meeting.

Apendix D

Intervention strategy photographic register
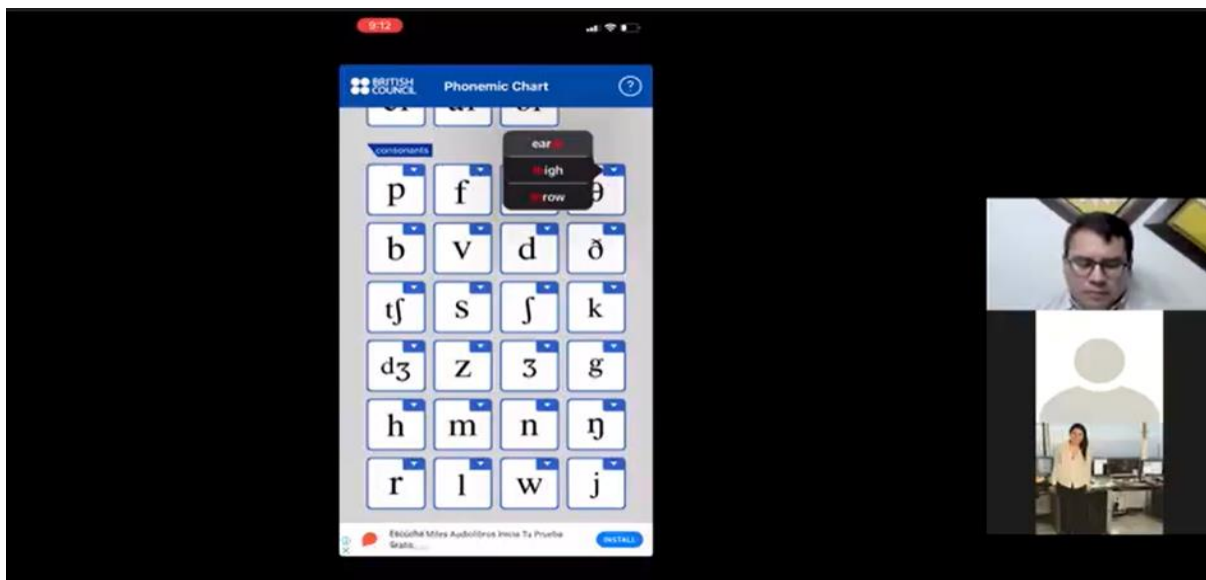
Photography 1; Using IPA App

Photography 2; Developing self-correction strategies using IPA