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Using Learner Corpora in Serious Game Design for English Phonology and Pronunciation Teaching

Mahdi Amazouz♦
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Interest in using games to impart knowledge has grown tremendously over the past few years. With their growing popularity and diversity, serious games offer new perspectives in Second Language Acquisition (SLA). However, with their increasing presence inside the classroom, a research-based framework is necessary to understand their functioning and identify the required structural elements of a serious game. This research highlights the pedagogical aspects that need to be considered when designing a serious game that attempts to meet students' educational needs. In this paper, we first define the concept of Serious Game Mechanics (SGM) and explain why we have decided to develop a serious game to teach English pronunciation. In the second part, we will display our research method and comment on the result of our analysis of students' phonemic transcription errors. We finally conclude with a summary of the targeted pedagogical priorities and competencies that we have included in our serious games and an analysis of students' progression.

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Serious Game Mechanics (SGM)

Learning occurs when the mechanics of a serious game allow us to practice and acquire the target language. Arnab et al. (2015: 2) explain that:

> The concept of Serious Game Mechanics (SGM) is the design decision that concretely realises the transition of a learning practice/goal into a mechanical element of game-play for the sole purpose of play and fun.

Simulation, a current game mechanic, can be used to allow training. Quests allow knowledge acquisition; ranking and game levels give feedback on the degree of acquisition and can be used to evaluate learners.

Over the past few years, different approaches to game integration in language classrooms have arisen. The first and earliest approach aims at using existing commercial games and game mechanics in classrooms to gamify the learning process (gamification). A second and more ambitious approach focuses on designing and creating language learning games that answer learners' specific needs (serious gaming). Sykes et al. (2012: 39) define "game-based L2TL" in contrast with "game-enhanced L2TL" (use of vernacular and commercial games in L2 teaching) as "the use of games and game-inclusive synthetic immersive environments that are designed intentionally for L2 learning and pedagogy". When designing a serious game for learning the pronunciation of English and more precisely learning the International Phonetic Alphabet (IPA) in "Licence" (French Degree in English Language, equivalent to BA), we have adopted this second approach. We have learned from the design process that a corpus-based approach to define the pedagogical content of a learning game is suitable.

A Serious Game for Second Language Acquisition (SLA)

At Paris University, we teach English phonetics and phonology to students enrolled in the first year (licence 1), in the second year (licence 2) and the third year (licence 3). The course includes the study of syllables and stress patterns, reading rules, an introduction to the study of intonation, specific courses in articulatory and acoustic phonetics, and phonology. Learning the International Phonetic Alphabet is the first and necessary step in the courses. Phonemic transcriptions based on written and audio documents are also used to assess learners' acquisition of the International Phonetic Alphabet (IPA). The overall purpose is to help students develop solid foundations in English phonetics and phonology. However, after six semesters of theoretical and practical courses, it

should be noted that the acquisition is only partial, and students make a lot of mistakes in their phonemic transcription and their pronunciation in general. Moreover, the learning process appears to be arduous for a majority of students who point out the complexity of the IPA. Although the majority of IPA symbols correspond to the "traditional" alphabet, difficulties arise as soon as a new symbol appears such as /æ/, /ʒ/, /ə/. Due to these difficulties, we have noticed a rejection of the learning process. As a result, we have decided to create a serious game to motivate students and bring them to a greater mastery of the IPA and phonemic transcription.

Learner Corpora and Language Teaching

A corpus-based approach was adopted to define the pedagogical principles that inform decision-making in the choice of activities and game mechanics in our serious game. The first corpora used in the context of second language acquisition were used to study learners' production errors. In this regard, Campillo-Paquet (2015: 49) explains that "*in the field of cognitive psychology, an error, like an iceberg, exhibits mental processes to which one does not have direct access*". According to De Cock and Tyne (2014: 2), analyses of learner corpora can allow us to observe the regularity of use of the target language and quantify certain aspects of language development.

When it comes to learning English pronunciation, transcription being the only accessible and quantifiable form of the acquisition of the pronunciation, it is necessary to analyse the form it takes (De Cock and Tyne 2014). In this perspective, the constitution of a corpus of phonemic transcriptions carried out by students allowed us to explore specific aspects of learning the International Phonetic Alphabet (IPA) and the pronunciation of English at university.

The underlying ambition is to collect a representative sample of L1, L2, and L3 students' transcription errors and determine a typology of errors. The results of our analyses provide an in-depth review of learners' most recurring transcription mistakes and accordingly define their specific needs when it comes to the study of phonetics and phonology. It is crucial to keep in mind that identifying these educational needs is necessary to define the activities and the game mechanics that we would use in our game. Moreover, it should be noted that it is quite difficult, if not impossible, to integrate all aspects of English phonetics and phonology in a serious game. This difficulty explains partly our corpus-based approach, which targets learners' mistakes and, accordingly, their learning priorities.

The analysis of these transcriptions also aims to offer new perspectives in teaching pronunciation. We will discuss more precisely, through our study, French learners' difficulties when learning the pronunciation of English and, to a greater extent, determine how to exploit these data to improve the learning process via serious games.

Method

The data of this study were collected using quantitative methods, whereby 106 student transcriptions were analysed. 35 enrolled in the first year (licence 1), 51 in the second year (licence 2) and 20 in the third year (licence 3). Taking into consideration French learners' difficulties with English pronunciation, the following words and sentenced were chosen:

> The North Wind and the Sun had a quarrel about which of them was the stronger.
> 1. booked, 2. monkey, 3. master, 4. Britain, 5. thumb, 6. liar, 7. measure, 8. earns, 9. carriage, 10. obey, 11. scheme, 12. judges, 13. aisle, 14. yawn, 15. don't, 16. oyster, 17. hair, 18. psycho, 19. would, 20. Alive

Using an IPA keyboard, we converted learners' written transcriptions into a SAMPA format. The *Speech Assessment Methods Phonetic Alphabet* (SAMPA) is a character set developed by researchers to encode IPA symbols via a keyboard. The EEC ESPRIT (information technology research and development program) developed this computer-readable phonetic script to encode special IPA symbols (not available on a keyboard) such as /@/ for schwa, or: /æ/ =/{/. IPA characters that can be encoded via a keyboard have been used identically. With a manual annotation of errors, we have carried out searches using regular expressions and the word processing software notepad ++ to form a typology of errors.

Corpus Analysis

There is a large number of anterior and posterior vowels for French. English, on the other hand, has several central vowels, which makes it difficult for students to learn how to pronounce them. These difficulties were materialized by an important number of vowel transcription errors.

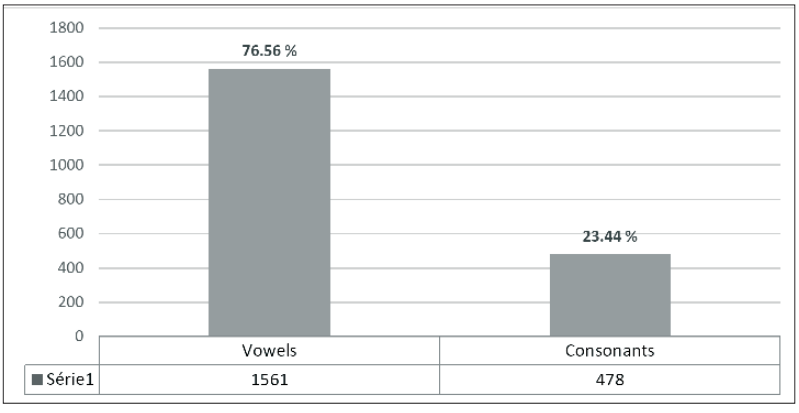


Figure 1: Number of vowel and consonants errors.

There are transcription errors for all types of vowels. Given that we have taken into account all accepted varieties[1] (British English and American English) in the same transcription, these results show a minimal mastery of the IPA. 1561 errors correspond to vowels and 478 to consonants. Short vowels count for 390 of transcription mistakes among which: /ɪ/=133; /ʌ/=90; /ɒ/=69; /æ/=47; /ʊ/=30; /e/=17. 485 correspond to a long vowel among which 352 are diphthongs: /əʊ/=113; /aɪ/=110; /ɔː/=47; /iː/=45; /eə/ =45; /aʊ/=42; /ɜː/=41; /ɔɪ/=28; /eɪ/=16; etc.

Regarding short vowels, the following lines list some examples of confusions.

- /ɪ/: many students used /i/ or /iː/ and a fair number did not transcribe the vowel. Some transcribed /e/ or /ə/.
- /ʌ/: here the vowel /ʌ/ was confused with /ə/, /ɒ/, /u/, /ʊ/, or even /æ/.
- /ɒ/: many errors include the use of /a/, /ɑ/ and /æ/ and we also found the vowel transcribed /ɑː/, /ɔː/ and /ə/.
- /æ/: this vowel was mistaken for /ɑ/, /e/ and /ə/

As for diphthongs, we suggest some examples of errors below.

- /əʊ/: students transcribed this vowel /ɒ/, /o/ or /ɔː/, /ə/, /ʊ/ or even /ɑː/.
- /aɪ/: errors of transcription here include /ɑɪ/, /ai/ and /aj/.

599 errors correspond to the vowel schwa /ə/, which shows the problem of stress patterns and vowel reduction in English for French learners.

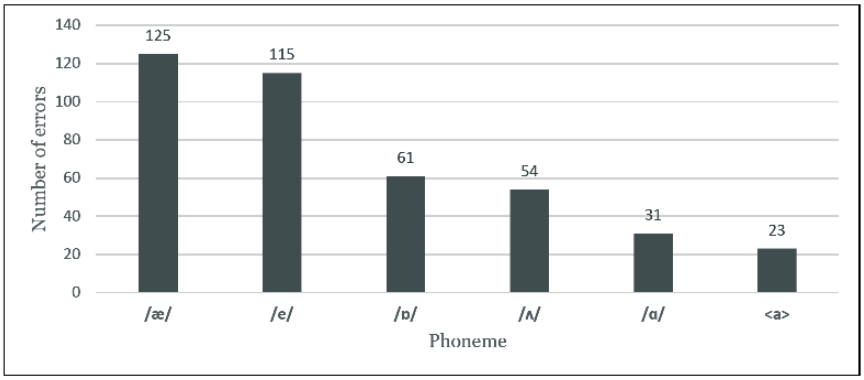


Figure 2: Vowels students used instead of the schwa.

The short vowel /æ/ was used instead of the schwa 125 times. Other occurrences include /e/ n=115, /ɒ/ n=61 and /ʌ/ n=54. The phoneme /ɑ/ was used 31 times. Students also used non-IPA symbols and graphemes such as: <a> 23 times.

These errors mainly correspond to the transcription of grammatical words with full vowels which shows a certain paralysis of students when it comes to vowel reduction.

1 During the internal and the external CAPES examinations, candidates must indicate the chosen variety of English and be consistent with it throughout the transcription.

Towards a Typology of Obstacles

The lack of training induces several critical difficulties in learning the pronunciation of English. Our survey shows that students have acquired only a minimal mastery of the IPA. Interference of the mother tongue in their acquisition of the IPA and acquisition of English speech sounds is among the obstacles that hamper the learning process.

Unlike the mother tongue, which is acquired unconsciously and naturally, the acquisition of a second language requires a certain intellectual effort (Krashen, 1985). During the learning process of an L2, we see the emergence of an interlanguage, an intermediate language, halfway between L1 and L2 (Adjemian, 1976). In this regard, an interlanguage obeys language rules from L1 and L2 at the same time. This language behaviour, which is undoubtedly beneficial when starting to learn a new language tends to mislead learners at an advanced level and hinders progression in the development of the target language.

In addition to the problem of language interference, a certain number of difficulties arise due to the differences in point and manner of articulation of the French and English phonological systems. According to Flege (1987: 49):

> difficulty in producing L2 phones authentically might be motoric in nature. Adults might be generally less able than young children to develop new articulatory patterns or to translate the sensory information associated with L2 phones into stable motor control patterns.

Furthermore, the suprasegmental (intonation, stress, rhythm, etc.) differences between English and French exacerbate these pronunciation difficulties. This is particularly the case with regard to stress pattern differences in English and French.

Faced with the difficulties of learning English pronunciation, a number of students point out the inconsistency of the writing system of English with its pronunciation. Words in <gh> which are pronounced /f/ (enough=/ɪˈnʌf/; rough=/rʌf/), words in <igh> pronounced /aɪ/ (sigh, might), and the pronunciation of the consonant <d> in worked /wɜːkt/ are examples of this inconsistency between spelling and speech.

An interference between writing and transcription also occurs due to the lack of bi-univocity between these systems. Ballier (2004: 13) indicates that the use of a new semiotic system (IPA) increases the risk of confusion between letters and symbols and between phonetic symbols. Some errors are directly linked to the spelling and lack of knowledge of the IPA and the grapheme-phoneme correspondences. We count 209 graphemes in students' transcriptions. The most recurring ones are: <a> and <o> similarly, a "*spelling transgression*" occurs

when the <c> is transcribed by /c/ instead of the phonemic symbol /k/ (Ballier, 2004: 11). These errors show a certain symbol/letter literality that arises from the proximity that may exist between the symbols of the IPA and the letters of the Latin alphabet. Also, writing IPA symbols presents additional difficulties to students; 324 transcription errors or erroneous combination of symbols have been recorded (/ʊː/; /at/; /aɪː/; /ɒː/; /Uə/.)

Learning Priorities

Our analyses show that learners' errors are mainly due to confusions between letters and phonetic symbols, a lack of knowledge of the grapheme-to-phoneme correspondences, and the inability to apply appropriately vowel reduction in unstressed syllables, as pointed out by Mompean (2015). Based on our analyses of students' transcriptions we have defined three areas for improvement: phonemes, reading rules and stress patterns. Six levels of competence are identified below for learning word stress patterns. Three levels of mastery for L1 students and three advanced levels for L2 and L3 students.

	A1	**A2**	**B1**
Phonemic level	– mapping IPA symbol with their corresponding sounds & vice versa	– distinguishing and transcribing all the various phonemes when listening to a word form	– reading written forms and transcribing with corresponding IPA symbols
Word-stress pattern	– syllabifying word forms; – explaining what stress is; – identifying stressed and unstressed syllables; – assigning stress in words ending with *eer*, *-ee*, *-ese*, *-ette*, *-ade*, *oo,* -een, -oon (strong endings).	– identifying and explaining stress neutrality of weak suffixes (*-dom*, *-ing*, *-ness*, etc.); – assigning stress in words ending with *-ic(s)*, *ical*, *-ity*, *-ate*, *-i+V-* (strong endings), -ify/-efy	– assigning secondary stress and transcribing related vowel; – assigning stress in adjectives with strong endings such as *-al* and -ous, as in *'**ver**tical* vs *hori'**zon**tal.*
Graphophonemics (reading rules)	– transcribing word final *-ed* and *-s*	– transcribing special consonant monographs such as <x>, <s>, <c+e/i> vs <c+a/o/u> and digraphs such as <ph>, <ch>, etc.	– transcribing vowel monographs in stressed syllables in relation to their right-hand contexts (hiatus, one or more consonants, etc.) & exceptions.

Table 1: Learning priorities for L1 students (Amazouz, 2021).

In Figure 3, for example, the teaching of word-stress placement in words ending with *een/eer, oo/oon*, *ade*, *ese* and *-ette* falls under the level of competence A1 because the stress rule is very simple in such cases: primary stress falls on the last syllable so that the endings are usually called "stressed-endings". The location of stress in words ending in *ic(s)*, *ical*, *ity*, *ate*, and *i+V* is more difficult to explain to learners because primary stress may fall on the penultimate or antepenultimate syllable so that they have to compute the number of syllables to find the correct stressed syllable. In this respect, the teaching of word-stress placement in such words is aimed at the level of competence A2.

	B1	**C1**	**C2**
Phonemic level	-describing vowel & consonants sounds (articulatory descriptions).	-distinguishing and transcribing minimal pairs in English (vowels & consonants).	-identifying contexts for /r/-linking, intrusive /r/, regressive & progressive assimilation, consonant cluster reduction, etc.
Stress pattern	-assigning stress in dissyllabic prefixed and non-prefixed word forms. -assigning stress in prefixed word forms of more than 2 syllables.	-identifying and stressing (classical) compounds.	-identifying stress-shift environments and applying stress-shift rules.
Graphophonemics (reading rules)	-transcribing vowels followed by <r>, differences between rhotic and non-rhotic varieties of English.	-transcribing vowel digraphs: regular and irregular phonetic qualities (e.g. *obt**ai**n* vs *mount**ai**n, p**ai**n vs p**ai**r*).	-transcribing consonant clusters with silent letters such as *kn-* as in *know*, *-mb* as in *dumb*, *-lk* as in *talk*, etc.

Table 2: Learning priorities for L1 students (Amazouz, 2021).

Better knowledge of the main stress patterns and the relationship between written and spoken forms of the language can improve students' pronunciation. Guierre's work (1987) on reading rules and stress patterns in English has had a significant impact on how pronunciation is taught in France. However, due to lack of training and motivation, the assimilation of these rules remains incomplete. Consequently, it is necessary to define specific learning priorities and contextualize the learning process through automation and optimization strategies.

Serious Games Development and Integration

We relied on the multiplatform game engine UNITY[2] to develop a serious game that students can use autonomously. IPA Word Maze allows you to work on word transcription and lexical stress in English. In addition to this game, we also used the LearningApps[3] platform to produced "apps" and Mentimeter[4] to create quizzes whose focus is phonemic transcription.

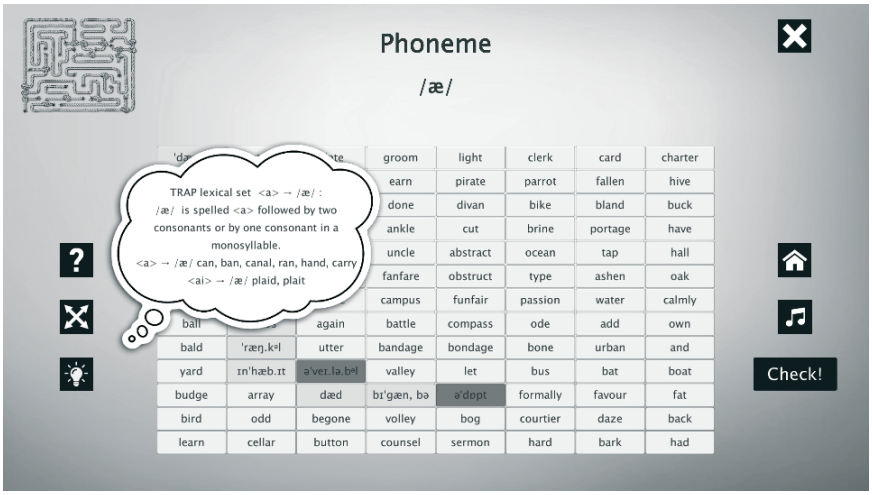


Figure 3: Screen capture of the IPA Word Maze game (Amazouz, 2021).

In IPA Word Maze, the player must navigate the maze and select words that share the same phoneme or correspond to the same stress pattern. Players can click on words to listen to their pronunciation and select them. For each of the 104 words that make up the maze, we indicate the corresponding pronunciation and the phonetic transcription that appears when the player checks a word or a series of words. The game includes three types of mazes: IPA (reverse transcription), Alphabet, and Word Stress. The game also includes tips learners can consult while playing by clicking on the lamp icon. If we take the example of the vowel schwa, the following reading rules are integrated.

2 https://unity.com/.
3 https://learningapps.org/.
4 https://www.mentimeter.com/.

In initial position, the predominant spelling is <a>: abide, aboard, about, ahead, adopt → */əˈbaɪd/, /əˈbɔːd/, /əˈbaʊt/, /əˈhed/, /əˈdɒpt/*
In medial position, in words in <-ative>, <-able>, <-al>, <-ial>, <-some>, <-um>, <ous>, <-us>, <-ard>, <-ock>, <-op>, <-on>, <en>, <an>: remedial, blossom, royal, editorial, material, procure, biological, *atrium, bacterium,* etc.
/ə/ behaviour, /əd/ steward, */dəm/ freedom, /ən/ Persian, /əs/ circus, /ək, əp/: bullock, pillock*, */əbəl/ adorable, etc.*
In final position <a>: data /ˈdeɪtə/, arena /əˈriːnə/, etc.
In final position <-er>: number, oyster, ladder, water, etc.

Figure 4: Reading rules that correspond to the vowel schwa.

Twolve quizzes were also created, each one lasting about 15 minutes, and students are invited to play synchronously online. During these sessions, we focused mainly on sentence transcription and vowel reduction.

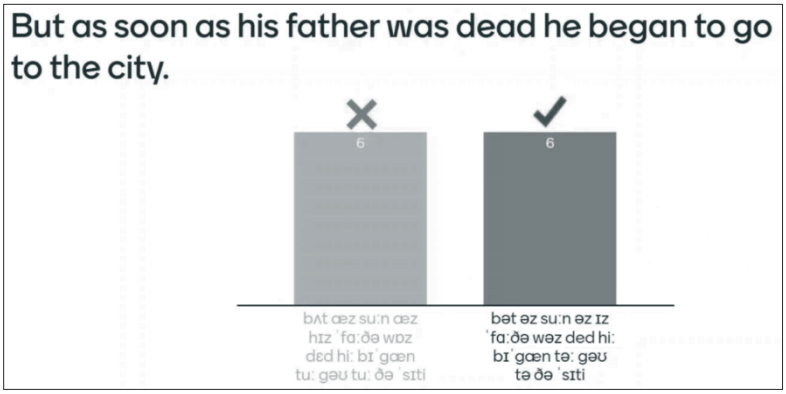


Figure 5: Screen capture of the quiz.

In speech, function words (conjunctions, prepositions, articles, and auxiliaries) are generally unstressed and their vowels reduced. Below another example of a sentence retrieved from Jobert and Mandon (2009) for which learners had to choose the correct transcription:

> But as soon as his father was dead he began to go to the city.
> /bʌt æz suːn æz hɪz ˈfɑːðə wɒz dɛd hiː bɪˈgæn tuː gəʊ tuː ðə ˈsɪti/
> /bət əz suːn əz ɪz ˈfɑːðə wəz ded hiː bɪˈgæn təː gəʊ tə ðə ˈsɪti/ (✓)

Results

In order to assess the added value of serious games to the learning process, 35 out of the initial 106 students transcribed a second list of words and a sentence at

the end of the semester[5]. 18 volunteers were part of the experimental group and 17 were part of the control group.

> In the last part of May the sky grew pale and the clouds that had hung in high puffs for so long in the spring were dissipated […] as soon as the valley and the mountain…
> 1. typical 2. kidney 3. advance 4. mountain 5. column, 6. octopus 7. following 8. curbs 9. marriage 10. perceive 11. badges 12. misbehaviour 13. maths 14. added 15. certain 16. oyster 17. colosseum 18. senate 19. abrupt 20. Curator.

Although the second list of words above is slightly more difficult than the first one (pre-test), it appears that 80% of the students who have played the game have improved the quality of their transcriptions. 15 students out of 18 made fewer errors and on average transcription errors were reduced by 41%. The number of errors in students E-017 and E-004 was reduced from 22 and 21 transcription errors, respectively, to one error each. Likewise, E-19 also shows a notable improvement and reduced the number of mistakes from 23 to 10.

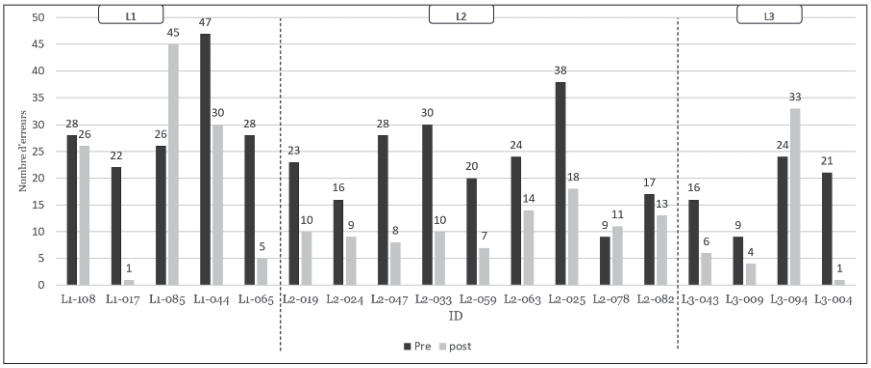


Figure 6: Comparison of students' pretest-posttest transcriptions (experimental group).

E-085 and E-094, on the other hand, made more mistakes, 26 to 45 and 24 to 33 transcription errors, respectively. Both participants, nonetheless, indicated they participated in "3 to 5 rounds" only. Likewise, E-78 makes more mistakes than during the pre-test (9 to 11). This student also indicates to have taken part in "one to two rounds" only. All of these students did not play the IPA Word Maze game.

5 The COVID-19 pandemic led to the closure of schools and universities. Distance learning was expanded to ensure a certain pedagogical continuity.

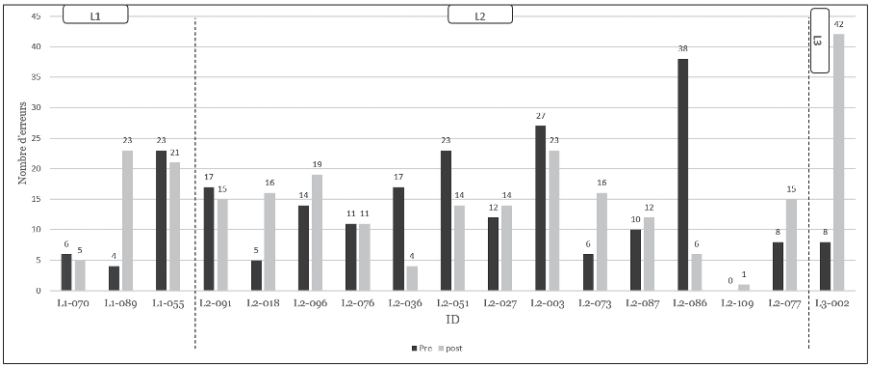


Figure 7: Comparison of students' pretest-posttest transcriptions (control group).

Regarding the control group, seven students out of 17 showed an improvement in the accuracy of their transcriptions. C-086 made 38 errors at the beginning of the semester and six errors at the end. C-051 and C-003 reduce the number of errors from 23 to 14 and 27 to 23 errors, respectively. Likewise, C-091 and C-036 go from 17 to 15 and 17 to 4 errors. On the other hand, C-002 went from eight errors to 42, C-089 from four errors to 23, and C-073 from six to 16 transcription errors.

Discussion

Mompean and Fouz-González (2021) identified several potential benefits in learning phonetic transcription when learning pronunciation. These affordances include systematicity, awareness-raising, visualness and visual support in teaching/learning, and autonomous learning.

Systematicity refers to the relationship between a phoneme and its graphic representation (IPA), which is said to be a one-to-one relationship. It allows learners and teachers to work precisely on phonemes and the pronunciation of the target language. Awareness-raising allows precise work on stress patterns and vowel reduction. When reading, learners can easily miss some of the features of L2 speech. Visualness and visual support in teaching and learning is another affordance. It refers to the materialization of sound, which allows a better understanding of the target language's phonological system. Finally, autonomous learning refers to the metacognitive work of the learner who plays a more active role in the learning process. Analyses of learners' transcriptions show that feedback is the main source of improvement. According to Mompean & Fouz-González (2021: 1):

> Despite shifting views on some instructional matters, there is a general consensus that it is hard to change certain aspects of L2 pronunciation substantially without specific training (Derwing et al., 2006; Pennington, 1998). (Mompean and Fouz-González 2021)

Lester et al.'s (2020: 56–57) study on serious games shows that feedback and guidance in game-based learning environments hold "*the potential to promote deeper learning experiences and enable learners to focus on the most salient aspects of a learning scenario.*" According to Sykes et al. (2012: 56–57):

> When feedback is untimely and not recycled into further learning, internalization is minimal. In good digital games, by contrast, real-time immediate feedback is a foundational mechanism that promotes successful gameplay and internalization, because the player perceives a sense of agency with ever choice, and choices are discernible and integrated.

If we take the example of the Mentimeter quiz, our analyses of the gaming sessions and players' interactions with the game show that students understand and assimilate better the rules they are presented with. If we take the example of vowel reduction in function words (*the, a, and*, etc.) in sentences, all players choose the correct transcription after receiving feedback on their previous erroneous answers.

Conclusion

De Cock and Tyne (2014: 145) stress that although "the characteristics of the interlanguage brought to light by studies of learner corpora do not necessarily have to give rise to educational applications" it is necessary to examine the question of their relevance. In this study, a corpus-based approach allowed us to shape educational practices that are consistent with learners' pedagogical needs. This study shows that obstacles to learning the IPA stem partly from students' lack of understanding of graphophonemic and phonographic correspondences, in addition to difficulties in learning stress patterns and vowel reduction. Lack of motivation is another factor that hinders the training process. Students often perceive these exercises as tedious and time-consuming. As a result, their transcriptions remain below lecturers' expectations.

Feedback on learners' mistakes and the adequate matching of learning material with their learning needs helped significantly reduce the number of mistakes. 80% of the students who played the games improved the quality of their transcriptions. On average, transcription errors were reduced by 41%. Nonetheless, it should be noted that a subtle balance between learning and playing must be struck when designing a serious game to engage learner's interest while making them progress. Finally, the integration of these pedagogical tools in the learning process must be contextualized to ensure a certain educational continuity.

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