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Unlocking Phonological Proficiency: Exploring Allophonic Variation Using ELSA Speak App in Early Semester EFL Students at Mulawarman University

Desy Rusmawaty [1], Effendi Limbong [2], Ichi Ahada [3], M. Indra F. Hafizh [4], Achmad. N. Rahmatullah [5]

[1,2,3,4,5] *Mulawarman University, Indonesia*

desyrachman2018@gmail.com, effendilimbong@fkip.unmul.ac.id, ichiahada@fkip.unmul.ac.id, indrahafizh62@gmail.com, achmadnabel104@gmail.com

Abstract:

Phonological proficiency is crucial for language growth in current English as a Foreign Language (EFL) education. The research aims to identify and analyze the proficiency of allophonic variations in students' phonetics using the advanced language learning tool ELSA Speak. It provides insights into their phonological development. This study employs a pre-experimental design methodology. A cohort of 31 EFL students from Mulawarman University participated in structured phonetic exercises using the ELSA Speak app around the beginning of the semester. Data was collected using pre-and post-tests, recording students' phonetic outputs, and entering detailed records of their engagement with the ELSA Speak app. The pre-experiment design enabled the evaluation of improvements in identifying allophonic variance and phonological competence before and after the intervention. The findings demonstrate a significant improvement in students' ability to detect and produce different variations of sounds, especially concerning allophones. The ELSA Speak app succeeded by offering immediate feedback, facilitating a more advanced understanding of phonetic distinctions. Based on the data, students demonstrated increased confidence and precision in their pronunciation, reassuring the students about the positive impact of the study. Additionally, they made significant progress in differentiating between challenging allophones for Indonesian and English. This study has highlighted the effective use of the ELSA Speak app in an English as a Foreign Language (EFL) setting, establishing its value as a beneficial tool for teaching pronunciation. The empirical data on the effectiveness of digital tools in improving the phonological competence of EFL students in the early stages of the semester can inspire and motivate educators, researchers, and professionals in English language education and linguistics to integrate such tools into their teaching practices.

Keywords: *Allophonic Variation; ELSA Speak; Phonetics; Phonology Competency*

1. INTRODUCTION

Unquestionably, globalization has significantly impacted many spheres of life, including cultural, political, economic, scientific, educational, technical, and information exchange (Mustakim & Lateh, 2020). Emphasizing the critical need for good communication, the need for translators or interpreters as mediators has exploded in this age of global connection. Particularly in an increasingly linked society, pronunciation abilities guarantee effective communication. Still, pronunciation accuracy is a continual difficulty for foreign language learners—even at the university level. Mulawarman University's English Education Department students especially find this problem pronounced.

Pronunciation accuracy for English as a Foreign Language (EFL) students must be balanced. Correct articulation is essential for effective communication. Individuals with weak phonological competency may need help communicating effectively, sometimes resulting in misunderstandings and miscommunication. It leads to notable ramifications within academic, professional, and social environments, including restricted career opportunities and social isolation. Phonological competency encompasses the capacity to understand and generate the phonetic components and intonation patterns of a language, which are crucial for both fluency and understanding (Adawiah & Muliati, 2024). It is not just about sounding like a native speaker but also about understanding and producing the sound and intonation patterns of the target language. This is essential for fluency and comprehension.

With developments in technology and digitalization as the global world welcomes the age of Industry 4.0, the scene of education changes. The educational and learning process fits Industry 4.0's tendencies, in which digital-based media takes the front stage and learning is not limited to the classroom (Qureshi et al., 2021). Rising online learning apps let students access course materials anywhere and anytime (Ismail et al., 2019). Like most of their classmates worldwide, Mulawarman University students are active internet users, which opens the path for a new paradigm in education.

Studies have shown that ELSA Speak cannot affect all students. Rinaepi et al. discovered that ELSA Speak may enhance students' pronunciation by 17% (Rinaepi et al., 2022). However, because of differences in individual aptitude and motivation, it may not be universally beneficial for all students. While ELSA Speak offers comprehensive feedback and engaging exercises, a separate study has shown that technology may need to fully address the intricacies of pronunciation (Adawiah & Muliati, 2024), such as students' difficulties in perceiving and visualizing different pronunciation patterns. Moreover, some kids may not respond as positively to the application as others, leading to varying levels of effectiveness. These findings suggest that while ELSA Speak may benefit many students, it may only be a panacea for some learners' pronunciation challenges.

The present study aims to investigate and analyze the allophonic variations in students' phonetics using the advanced language learning tool ELSA Speak. This study shows how successfully ELSA Speak provides interactive exercises and comprehensive feedback to improve students' pronunciation.

2. LITERATURE REVIEW

2.1 Phonological Proficiency

Phonological proficiency, which refers to the ability to identify, analyze, and manipulate the sounds in spoken language, is a crucial aspect of language development. The two primary types of skills are phonemic awareness and phonological sensitivity. Phonemic awareness concerns the smallest sound units, phonemes, whereas phonological sensitivity involves awareness of larger language units such as words, syllables, onsets, and rimes. The word "that" has three phonemes: the "th" represents one phoneme, the "a" corresponds to the short a sound, and the "t" represents its basic sound (Griffin, 2022). Proficiency in reading and spelling relies on the development of phonological competence, which is essential for understanding the mechanics of spoken language and effectively applying that understanding to written language(Gleason, 2001).

Acquiring phonological proficiency poses considerable problems for EFL students. A significant challenge in English phonology lies in the intricate phonetic differentiations and extensive allophonic variations. Students need help to acquire proficiency in these distinctions, resulting in difficulties with intonation patterns and precise phonetic articulation. Susanto explicated that the lack of direct teaching on English phonology in language programs adds to the complexity of the topic since students are forced to depend on implicit learning strategies such as noting pronunciation patterns and listening to native speakers (Susanto, 2018).

Lack of opportunities to exercise and enhance their phonological skills is also one of the challenges experienced by EFL learners. Classrooms often prioritize grammar and vocabulary over pronunciation, resulting in limited opportunities for learners to enhance their pronunciation skills actively (Alsalihi, 2020). The insufficiency is exacerbated by the absence of excellent speakers or adequate language learning resources for many EFL learners, hindering their capacity to improve their phonological skills effectively. Furthermore, the fear of making pronunciation mistakes might hinder learners' desire to practice and improve their pronunciation, thereby worsening the challenges they face in achieving mastery of phonology.

2.2 Allophonic Variation

Mitterer (2018) defines "allophonic variation" as the phonological phenomenon wherein various phonetic realizations of a phoneme manifest themselves in different ways, contingent on the context in which they are utilized. Students should have a strong awareness of this variance as it provides insights into the complexity of pronunciation, thereby ensuring that their speech is exact and appropriate for the surroundings. Starting the introduction of allophonic variation during the first semesters is of great relevance, depending on the results (Peperkamp, 2003). The process of acquiring a pronunciation like that of a natural speaker depends much on this language concept. Peperkamp argued that understanding how babies learn to discern between phonemes and allophones is crucial to help lower the inventory of segmental categories to an inventory of abstract phoneme categories.

Developing allophonic variations is very important for EFL students as it enables them to acquire exact pronunciation—a required talent for efficient communication. Allophonic variants—dependent on the phonetic context—are the many pronunciations of a similar phoneme. Depending on where the phoneme /t/ occurs in a word, for instance, it may be [t] or, [th]. According to Roach (2009), as one of the six English plosives, the sound /t/ is an alveolar voiceless plosive. Two articulators moving against each other generate a complete stricture when

/t/ is created, for which no air is expelled from the vocal tract. The air squeezed from the closure is then let to escape, audible as a burst of noise called plosion, akin to a sound boom. Alveolar plosives in English are /t/ and /d/. When generated alone, one fundamental distinction between /t/ and /d/, is voicing in that /t/ is voiceless while /d/ is voiced. A more potent air force helps the voiceless plosive /t/ be pronounced more than the voiced one /d/.

Moreover, for EFL students, acquiring allophonic variants is vital as it promotes phonological awareness, which is necessary for reading and spelling ability. Phonological awareness is how words' sounds are employed concerning written letters. Students who grasp allophonic variants can build the phoneme-grapheme and grapheme-phoneme links more successfully, permitting correct word reading and spelling. This is crucial as precise pronunciation and phonological awareness are closely related and required for natural and fluent English communication. The development of allophonic variants helps EFL students increase their general language competency, improving their English communication skills. Native speakers and the proper generation of English sounds depend on EFL students' understanding and mastery of these varieties. Students with this expertise might need help appropriately pronouncing words, leading to misunderstandings and better communication. Furthermore, delaying the introduction of allophonic variation might lead to the formation of habits incompatible with proper pronunciation (Prashant, 2018).

2.3 Technology in Language Learning

Technological developments have fundamentally changed language instruction, allowing students to access a vast array of materials and participate in interactive learning environments. Digital platforms, online corpus, and mobile learning tools have transformed language instruction and learning. Digital tools such as ELSA Speak, for example, provide individualized learning experiences, thorough comments, and interactive activities meant to assist students improve their general language competency and pronunciation (Iqbal et al., 2021). Furthermore, authentic online resources and online communication with others have become vital parts of language education, letting students engage with native speakers and practice real-life language skills (Yunus, 2018).These technical developments have improved the quality of language instruction, making it more interesting and easily accessible for students.

In addition, technological advancements have enabled the integration of technology-based learning and adaptive learning into language training. These technologies provide personalized learning paths, ongoing assessment of progress, and engaging activities that are specifically designed to meet the unique requirements and abilities of each student (Anggraini, 2022). Language learning tools such as Elsa Speak and Duolingo provide engaging vocabulary exercises, comprehensive grammar comprehension, and effective pronunciation drills, converting language learning from passive to active. Artificial intelligence (AI) has enhanced language acquisition by providing immediate feedback, personalized exercises, and the ability to identify and correct pronunciation and grammar problems. The advancements in technology have significantly improved the quality and accessibility of language training, hence enhancing its effectiveness and pleasure for students.

2.4 ELSA Speak Application

The shift toward a student-centered approach in education makes independent learning a progressively significant part of the educational process. Teachers' jobs have changed to facilitators, guiding students along their learning path (Purnama et al., 2020). Along with the

educational revolution, the ELSA Speak application has become a potent tool fit for the ideas of education linked with Industry 4.0. Under the academic revolution, the ELSA Speak application has become a powerful instrument suitable for education concepts connected with Industry 4.0. ELSA—English Language Speech Assistant—is an application created explicitly for Android devices. It is readily available for download on Google Play or the App Store. Using diverse exercises and tactics in learning English encompasses many components designed to enhance students' pronunciation.

ELSA Speak is a smartphone application that aims to assist those who are not native English speakers in improving their pronunciation and fluency (Anggraini, 2022). The system utilizes sophisticated voice recognition technology to assess users' pronunciation and provide feedback on their accent, intonation, and other speech characteristics. One of its distinctive advantages is its ability to be customized to meet the user's specific needs and learning preferences. The program's algorithm analyzes the user's pronunciation and customizes the lessons and exercises to focus on their unique areas of difficulty, ensuring that the learning process is tailored to their needs.

ELSA Speak enhances students' pronunciation skills via various activities and courses designed to refine their English-speaking proficiency in professional, travel, and social contexts (Kholis, 2021). The application enables users to access recordings of native speakers and enhance their English language skills via interactive courses that actively involve them in practising pronunciation. Users can establish their goals and track their progress, receiving detailed feedback on their performance and suggestions for improvement. In addition, the program provides contextual learning, which includes lessons and exercises in different circumstances to help users improve their communication skills and learn how to speak English in real-life scenarios.

3. RESEARCH METHODOLOGY

This study used a pre-experimental research methodology, explicitly opting for a pre-experimental design owing to time constraints. The limited available time allowed the research to be done on a single class, making it unfeasible to adopt a quasi-experimental design. The research included 31 first-semester students from the English Department at Mulawarman University. These students were recruited because they were in the early phases of their English education, with an emphasis on improving their pronunciation and speaking abilities. The research focused on this group to assess the efficacy of the ELSA Speak application in improving their phonological skills at the crucial first stage of their language acquisition process.

The study used pre-test and post-test measures, including a set of 10 words that included allophonic variants. Every item in the word pronunciation test was given a score of 1, as shown in Table 1. To conduct a thorough evaluation, every participant was given two chances to pronounce the things.

Table 1. The scoring system of the test

Tested Items	Score Per Item	Maximum Score
/s/ = 4	0.5 x 2 attempts	4.0
/p/ = 4	0.5 x 2 attempts	4.0
/k/ = 2	0.5 x 2 attempts	2.0
Total		10.0

The scoring process involves calculating the mean score obtained from the participants' performance throughout the two tries. More precisely, each correctly uttered item is assigned a score of 1. However, the average score is derived when both right and failed tries exist. For example, if a participant made an inaccurate pronunciation of an item in one try and then properly said it in another attempt, their score for that item would be 0.5. This rigorous scoring methodology enables a detailed assessment of participants' ability to handle subtle differences in pronunciation, accurately capturing both accurate and inaccurate occurrences.

The treatment phase followed the pre-test and provided students with instructions on accurately pronouncing three different kinds of allophonic variants via the ELSA Speak program. Students were required to download the application from either the AppStore or Play Store onto their cellphones or other electronic devices. The therapy was provided on a single day. Nevertheless, the testing phase for the ELSA Speak application was prolonged by one week, allowing participants enough time to engage with the app before submitting their self-administered post-test outcomes. The post-test replicated the pre-test in terms of its structure, content, difficulty level, and scoring method.

4. RESULTS

4.1. Findings

This section includes the findings of the present research. These results came from running the ELSA proficiency exam among thirty-one first-year students. As was already noted, this test comprised ten words. Table 2 revealed the mean scores from the pre-test and post-test.

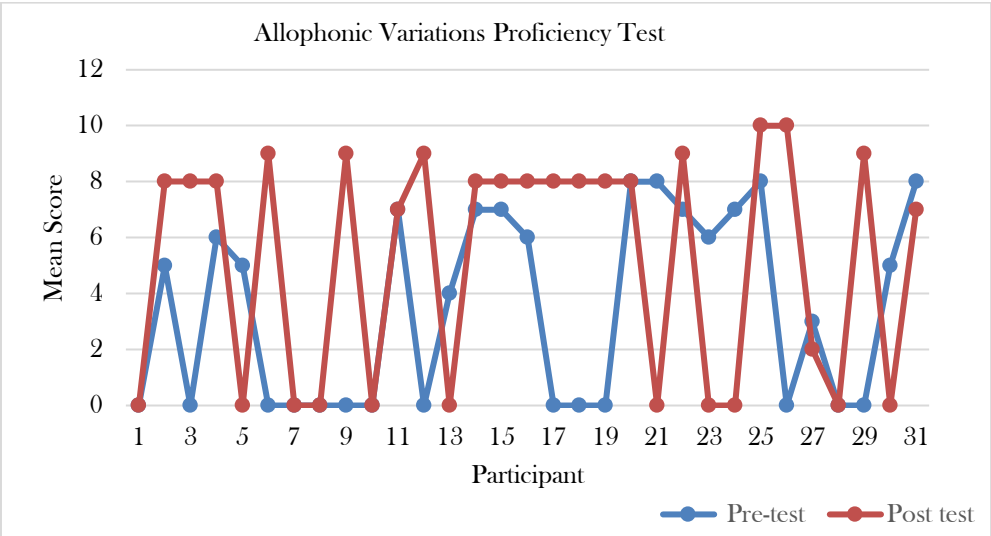
Table 2. Pre-test and post-test results.

No	Participants	Mean Score	
		Pre-Test	Post Test
1	Participant 1	5.5	7.5
2	Participant 2	5	8
3	Participant 3	6.5	8
4	Participant 4	6	8
5	Participant 5	5	7.5
6	Participant 6	7.5	9
7	Participant 7	3.5	7.5
8	Participant 8	5.5	7.5
9	Participant 9	3.5	9
10	Participant 10	1.5	7.5
11	Participant 11	7	7
12	Participant 12	4.5	9
13	Participant 13	4	8.5
14	Participant 14	7	8
15	Participant 15	7	8
16	Participant 16	6	8
17	Participant 17	7.5	8
18	Participant 18	3.5	8
19	Participant 19	6.5	8
20	Participant 20	8	8
21	Participant 21	8	6.5
22	Participant 22	7	9
23	Participant 23	6	6.5
24	Participant 24	7	8.5
25	Participant 25	8	10

No	Participants	Pre-Test	Post Test
26	Participant 26	5.5	10
27	Participant 27	3	2
28	Participant 28	3.5	5.5
29	Participant 29	3.5	9
30	Participant 30	5	8.5
31	Participant 31	8	7
	Average Score	5.64	7.82

Before the intervention, students underwent a pre-test designed to establish a baseline for the study. The results of this initial assessment are illustrated in Figure 1, providing a visual representation of the frequency distribution of the data.

Figure 1. Mean Score of Allophonic Variation



The chart reveals a considerable spread of scores among participants during the pre-test, with a standard deviation (SD) of 1.76. Notably, the lowest mean score attained by a participant was 1.5/10.0, while the highest mean score achieved by four individuals was 8.0/10.0. On average, all participants scored 5.64/10.0 during this phase.

The obtained data revealed that the allophonic variation of phoneme /s/ achieved the lowest score among the participants, with an average score of 0.36/1.0. It was followed by phoneme /p/, which achieved an average score of 0.69/1.0. The highest score achieved by the participants was phoneme /k/, which achieved a slightly higher average score of 0.70/1.0.

Mean Difference	2.18
Std. Dev.	1.98
Cohen's d	1.10

The study's Cohen's d value of 1.10 indicates that the effect size was substantial, as determined by the statistical analysis. This demonstrates that the students' language abilities greatly improved between the pre-test and the post-test because of utilizing the ELSA Speak. The substantial effect size demonstrates that the disparity between the pre-test and post-test scores is not only

statistically significant but also practical. Evidence indicates that the intervention significantly impacted the participants' auditory and vocal proficiency in producing allophonic variants.

The 1.98 standard deviation of the changes indicates that the variations in the extent of improvement among the students are rather uniform across the sample, further reinforcing this perspective. The reduced standard deviation, compared to the mean difference of 2.18, indicates a high level of consistency in the kids' progress in phonological abilities. This indicates that the application functioned well for a diverse range of learners. The findings demonstrate the significance of using digital tools such as ELSA Speak in English as a Foreign Language (EFL) classrooms to enhance students' phonological abilities.

The lower scores observed for the phoneme /s/ were primarily attributed to the participant's limited phonological awareness, particularly regarding allophonic variation. During the treatment phase, most participants admitted to being unfamiliar with allophonic variation before the study, and they needed to learn about the correct pronunciation of the tested words. One participant said at the end of the treatment, "*Before I knew Elsa speak pronunciation app, I pronounced the word "dogs" with 's' at the end of the word, but after I learned Elsa speak pronunciation app, the word "dogs" is pronounced with 'z' at the end of the word.*"

The classroom environment emerged as a potential contributing factor to the participants' lower scores during the pre-test (Jannah et al., 2023). Classroom settings may induce anxiety in students due to the presence of peers. In-class assessments, known for fostering a competitive atmosphere, have the potential to heighten overall anxiety levels, creating a risk of embarrassment (Suleimenova, 2013). The setting increases participants' anxiety, impacting their performance and potentially impeding their phonological awareness, especially concerning allophonic variation.

After the intervention, students underwent a post-test as part of the study to assess changes in their performance. Figure 1 depicts the post-test outcomes, illustrating the frequency distribution of the data results following the intervention. The histogram shows that the post-test resulted in a lesser spread of the score among participants, with an SD of 1.44. In addition, the lowest mean score obtained by a participant was 2.0/10.0, while the highest mean score retrieved was 10.0/10.0 obtained by two people. During this phase, the average score obtained by the participants improved massively to 7.92/10.0.

The post-test shows a significant improvement in all phonemes being tested. Phoneme /s/, although still the lowest, achieved double the average score from the pre-test at 0.67/10. In addition, the average score obtained by the participants on phoneme /p/ increased to 0.85/10. Lastly, phoneme /k/ still scored the highest by students on the post-test, with an average score obtained at an almost perfect 0.94/1.0.

5. DISCUSSION

This significant improvement in participants' post-test scores can be attributed to several factors. First, ELSA Speak provides advanced and regular feedback. While advanced feedback assesses the pronunciation of words, regular feedback evaluates the correctness of certain sounds or groups of sounds, helping learners understand which portion of the phrase was mispronounced. During an interview session, one of the students confirmed this: "*ELSA Speak improved my pronunciation. I can immediately fix and understand my errors owing to post-activity feedback. Advanced input that describes how to improve sounds helps me the most. Like having a*

personal coach who corrects my speech throughout. This continuous and exact criticism has boosted my English-speaking confidence." (S25)

ELSA Speak allows students to acquire accurate pronunciation via exposure to recordings made by native speakers. Additionally, students may refine their pronunciation skills by engaging in practice exercises and receiving digital feedback from ELSA Speak, enabling them to rectify any pronunciation errors(Saragih et al., 2021).

Second, ELSA Speak provides detailed reports. The application offers thorough analyses, including comments on individual phonemes, word stress, and segmental issues like consonant clusters and schwa. These tests let students rapidly find and fix their mistakes by using colour coding to signal correct (green), mainly accurate (yellow), and incorrect (red) pronunciations. From the interview, one student elaborated, "*I can see my report as ELSA Speak gave me detailed and comprehensive information. I am assessing my learning; it is good*." (S26).

Third, ELSA Speak presents a range of interactive games and activities to help students develop active pronunciation. These drills provide real-time feedback and let students compare their pronunciation with that of native speakers, therefore improving some aspects of pronunciation, like allophonic. The students shared that enjoyable and intriguing pronunciation games engaged him in learning and practising his pronunciation. He said, "*I like how ELSA Speak blends games with learning. Enjoyable and intriguing pronunciation games keep me playing.*" (S12).

The student admitted that conventional pronunciation instructions do not entice her to learn and practice her pronunciation. The pronunciation game from ELSA Speak employs listening and repeating words and short phrases to provide students with extensive feedback and improve active pronunciation (Elsani et al., 2023). A word stress game helps students pronounce words by emphasizing the correct syllables. Games featuring unscrambling words and missing letters engage students in active pronunciation practice, improving their overall pronunciation.

Fourth, the application customizes exercises and comments based on each student's strengths and shortcomings, addressing their requirements. It ensures focused practice on areas where students need development, including allophonic variants. With self-admission, participants may no longer feel the classroom pressure as the one with the pre-test. Instead, they can choose places they find comfortable and suitable for testing. Second, they have much time to prepare before the post-test begins through independent online learning with ELSA Speak. According to Ewell et al. (2022), online learning can allow students to participate in activities from various locations at times that suit their convenience. This adaptability, highlighted by many students in the study, provided additional preparation time and contributed to reduced anxiety levels. Consequently, participants generally perceived online learning as advantageous, citing its benefits in terms of flexibility and accessibility. In the final data analysis stage, the researchers used a paired sample T-test to examine the difference between pre-test and post-test variables. Specifically, the test was employed to identify changes in students' scores related to the pronunciation of allophonic variation words before and after the treatment.

Fifth, ELSA Speak is designed with topic-based learning. Lessons and activities in many settings—including travel, job interviews, and social events—are available via ELSA Speak. This contextual learning clarifies for students how to apply proper pronunciation in various situations, including allophonic variants relevant to those contexts (Yosintha & Rekha, 2022). It is seen from the excerpt below, "*There are many topics that benefited me. Every session covers a different subject or situation, making real-life pronunciation easier. Practising pronunciation in a job*

interview or casual conversation helps me use the proper sounds naturally. This improves my speech and English proficiency in numerous situations. Being ready for real-life circumstances increases my learning."

A paired-sample T-test is utilised to prove the significant difference in students' allophonic variation proficiency. The result is seen in Table 3.

Table 3. Paired samples t-test result.

Paired Samples T-test Result				
95% Confidence Interval of the Difference		t-value	Degrees of Freedom (df)	P-value (2-tailed)
Lower	Upper			
-2.90	-1.45	6.12	30	<0.0001

The paired sample t-test results indicate an extremely significant difference between pre-test and post-test scores, with a significance value (2-tailed) of $p = 0.0001 < 0.05$ (α). The paired sample t-test in data analysis showed the statistical significance of the observed improvement, with a p-value of 0.0001, confirming the rejection of the null hypothesis and supporting the acceptance of the alternative hypothesis. This difference led to the rejection of this study's null hypothesis (Ho), while the alternative hypothesis (Ha) was accepted. The findings suggest that ELSA Speak significantly enhanced students' pronunciation of allophonic variations, particularly for early-semester EFL students at Mulawarman University.

6. CONCLUSION

After elucidating the findings mentioned above, two important points must be addressed. First, students' allophonic variation competency has significantly improved using ELSA Speak in the learning process. Through its sophisticated voice recognition technology and interactive learning tools, ELSA Speak raises students' allophonic variation performance. Helping students find and fix mispronunciations, the application offers thorough comments on individual phonemes, word stress, and segmental issues. Interactive games and activities let students practice active pronunciation to compare their pronunciation with native speakers. ELSA Speak also provides customized learning opportunities tailored to each student's demands, guaranteeing focused practice on areas of need for development. Regular use of ELSA Speak helps students grasp allophonic variations and enhances their general pronunciation, boosting their English communication capacity.

Second, despite excellently improving pronunciation, ELSA Speak has some drawbacks. One main drawback is that it only focuses on pronunciation and ignores chances for comprehensive language acquisition, including training in grammar and vocabulary. Students who must develop these skills simultaneously may find this problematic. A few students have complained that the app could be too critical of little pronunciation errors, which irritates and promotes self-doubt. Moreover, because the program relies on technology, it requires a smartphone and internet access—qualities not probably accessible to every student. Furthermore, the content could be redundant; therefore, some users might find it challenging to find ways to go beyond the same feedback patterns. Despite these limitations, ELSA Speak is still a good tool for students who must improve their pronunciation, especially allophonic varieties.

It also highlights the program's shortcomings in addressing all the intricacies of phonological development. Although ELSA Speak could help students detect and correct individual phonemes, the study notes that it does not fully represent the intricacies of allophonic variations—necessary for generating native-like pronunciation. Moreover, the study suggests that the reliance of the application on automated voice recognition technology could not be able to justify the complexity of phonological rules and the learners' particular phonetic systems. Therefore, the studies recommend a more all-encompassing approach integrating ELSA Speak with other teaching methodologies to ensure better awareness and mastery of allophonic differences in students' phonetics.

The possible long-term effects of using the ELSA Speak app in English as a Foreign Language (EFL) settings should be considered to expand the research analysis further. This may entail exploring if the reported increases in phonological competence are maintained over time and how prolonged app use can impact total language skills, including fluency and understanding. Moreover, this could involve determining whether the ELSA Speak's effects are cumulative. Additionally, identifying more precise and quantifiable goals, such as monitoring changes in students' pronunciation confidence levels over multiple semesters or measuring the accuracy rates of allophonic output, might offer a better picture of the ELSA Speak's usefulness. Future studies might give a more thorough knowledge of digital tools' function in developing phonological abilities by combining longitudinal data and measurable results. This would provide teachers with more specific instructions for the implementation of digital tools in the classroom.

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