Bakalářská práce

Analysis of the Sounds /e/ and /ae/ in the English Pronunciation among Students of Technical University of Liberec: Computer-Assisted Pronunciation Training

Studijní program: B0114A300068 Anglický jazyk se zaměřením na vzdělávání

Studijní obory: Anglický jazyk se zaměřením na vzdělávání
Španělský jazyk se zaměřením na vzdělávání

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Zadání bakalářské práce

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Zásady pro vypracování:

Bakalářská práce bude analyzovat výslovnost vybraných fonémů mezi studenty studijního oboru Anglický jazyk se zaměřením na vzdělávání. Práce se zaměřuje na nepřesnosti ve výslovnosti fonémů /e/ a /æ/. Cílem výzkumu bude analyzovat problematický jev ve výslovnosti respondentů a následně zjistit, do jaké míry lze redukovat nedostatky v produkci zvolených hlásek. Práce bude rozdělena do dvou částí. V teoretické části budou popsány vybrané fonémy z hlediska jejich problematického užití v anglickém jazyce u českých studentů. Praktická část popíše metodu studie, výsledky a následnou interpretaci.

Zkoumaný vzorek bude tvořen výhradně studenty v prezenčním bakalářském studiu. V praktické části bude vytvořena sada elektronických cvičení na výslovnost fonémů /e/ a /æ/ za použití metody "Listen-and-Repeat". Následně budou pro účely zkoumání mluveného projevu pořízeny hlasové záznamy studentů na začátku výslovnostního tréninku, v průběhu a po jeho ukončení.

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V Liberci dne 26. června 2023

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10. července 2024   Kateřina Halamková

Anotace:

Tato bakalářská práce se zabývá analýzou výslovnosti vybraných fonémů mezi studenty studijního oboru Anglický jazyk se zaměřením na vzdělávání. Zkoumaný vzorek byl tvořen výhradně studenty prezenčního bakalářského studia Technické univerzity v Liberci. Práce se zaměřuje na nepřesnosti ve výslovnosti fonémů /e/ a /æ/. Cílem výzkumu bylo analyzovat problematický jev ve výslovnosti respondentů a následně zjistit, do jaké míry lze redukovat nedostatky v produkci zvolených hlásek pomocí počítačově podporovaného výslovnostního tréninku (CAPT). Práce je rozdělena do dvou částí. Teoretická část popisuje vybrané fonémy z hlediska jejich problematického užití v anglickém jazyce u českých studentů. V praktické části byla vytvořena sada elektronických cvičení zaměřených na rozlišování mezi výslovností fonémů /e/ a /æ/ založených na metodě "Listen-and-Repeat". Následně byly pro účely zkoumání mluveného projevu pořízeny audio nahrávky studentů na začátku výslovnostního tréninku, v průběhu a po jeho ukončení. Analýza nahrávek zahrnovala jak subjektivní poslechové hodnocení, tak analýzu pomocí PRAAT software. Tyto analýzy prokázaly, do jaké míry se výslovnost účastníků výzkumu díky CAPT skutečně zlepšila.

Klíčová slova:

Počítačově podporovaný výslovnostní trénink (CAPT), metoda Listen-and-Repeat, PRAAT, výslovnost, výuka anglického jazyka, studenti TUL

Abstract:

This bachelor's thesis focuses on the analysis of the pronunciation of selected phonemes among students studying English with a focus on education. The research sample consisted exclusively of full-time undergraduate students at the Technical University of Liberec. The study focuses on inaccuracies in the pronunciation of the /e/ and /æ/ phonemes. The aim of the research was to analyse the problematic phenomenon in the pronunciation of the respondents and then to determine to what extent the deficiencies in the production of the selected phonemes can be reduced by means of computer-assisted pronunciation training (CAPT). The thesis is divided into two parts. The theoretical part describes the selected phonemes in terms of their problematic use in the English language by Czech students. In the practical part, a set of electronic exercises was created to address the distinction between the pronunciation of the /e/ and /æ/ phonemes based on the "Listen-and-Repeat" method. Subsequently, audio recordings of the students at the beginning, during and after the pronunciation training were made for the purpose of examining their speech. Analysis of the recordings included both subjective auditory assessment and PRAAT software analysis. These analyses demonstrated to what extend the pronunciation of the research participants had improved as a result of undertaking CAPT.

Keywords:

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List of Abbreviations

AA – Auditory Assessment

AI – Artificial Intelligence

ASR – Automatic Speech Recognition

CALL – Computer-Assisted Language Learning

CAPT – Computer-Assisted Pronunciation Training

F1 – Formant 1

L2 – Second Language

PT1 – Pre-Test

PT2 – Post-Test

RP – Received Pronunciation

TUL – Technical University of Liberec

VR – Virtual Reality

Introduction

In an increasingly interconnected world, the ability to communicate effectively in English has become a fundamental skill for people in various academic and professional spheres. However, achieving accurate pronunciation of English sounds, especially those that do not exist in the native language of many learners, remains a persistent challenge.

This bachelor thesis examines a particular aspect of English pronunciation: the distinction between the vowel sounds /e/ and /æ/. The differences between these two sounds may seem subtle, but they play a significant role in distinguishing words and conveying meaning in English. For non-native speakers, mastering this phonemic contrast can be notably challenging due to the absence of these consonants in several languages.

The study primarily focuses on students of English for Education at the Technical University of Liberec and addresses the practical need for students to communicate effectively in English by focusing on specific pronunciation challenges. The focus of the thesis is twofold. Firstly, to investigate the level of accuracy in the production of the vowel sounds /e/ and /æ/ among students at the Technical University of Liberec. Secondly, to evaluate the effectiveness of Computer Computer-Assisted Pronunciation Training (CAPT) programmes in improving the pronunciation of the mentioned vowel sounds. This should provide insights that can lead to more targeted and effective language teaching and ultimately improve students' English language skills with the use of CAPT.

The research aligns with the overall trend of integrating technology into language learning. As such, it contributes to the growing body of literature on the effectiveness of technology-based language teaching methods, which is relevant not only for the Technical University of Liberec, but also for language teachers and institutions worldwide.

Furthermore, while the existing studies do frequently address broader aspects of pronunciation, this research narrows its focus to a specific contrast between the /e/ and /æ/ sounds, which can be challenging for Czech speakers due to the absence of the /æ/ sound in their native language.

1.   Theoretical Background

Pronunciation, the core element of language, has a key role in effective communication and language acquisition. The ability to articulate properly is just as crucial as grammatical knowledge and vocabulary in the process of foreign language (L2) learning.

1.1. Pedagogical Approaches to Pronunciation Instruction

Pedagogical approaches to pronunciation instruction involve a wide range of strategies and techniques designed to support learners in developing accurate and comprehensible pronunciation. These approaches can be categorised as traditional and modern, each with its own set of methods and approaches.

1.1.1. Traditional Pedagogical Approaches

Early teaching methods of pronunciation often consisted of mimicry and repetition, with little attention to the underlying phonetic principles. This might have led to distinction solely between "correct" and "incorrect" pronunciation, frequently dependent on native speaker norms. Therefore, traditional pedagogical approaches included audio-lingual methods that focused on repetition and imitation, when students were required to listen to native speakers and subsequently imitate their pronunciation and intonation habits. This method became prevalent in the mid-20th century (Celce-Murcia, Brinton, Goodwin 1996, 2-3).

Another important part of traditional teaching methods was phonetic practice. In this case, the emphasis is on individual pronunciation exercises. Students practise individual syllables, stress and intonation patterns via repetitive activities and exercises. (Celce-Murcia, Brinton, Goodwin 1996, 2-6). However, as the field of linguistics progressed, a more varied understanding of phonetics and phonology emerged, leading to a more systematic and science-based approach to pronunciation instruction.

1.1.2.   Modern Pedagogical Approaches

The arrival of technology, in particular the availability of audio-visual recording, has significantly transformed the way pronunciation is taught. Computer-assisted pronunciation training (CAPT) and speech recognition software have provided language learners with instant feedback, allowing for self-guided practice and assessment. Furthermore, contemporary pedagogical techniques, such as the communicative approach and task-based language teaching, continuously incorporate pronunciation instruction into a comprehensive language learning experience.

The communicative approach integrates pronunciation into the context of purposeful communication. It promotes a more natural and effective attitude towards pronunciation by emphasising comprehension and understanding in real-life situations (Littlewood 1981, 85). Doughty and Williams (1998, 1-4) researched similar approaches which focus on form, combining authentic conversational activities with pronunciation instruction and engaging students in authentic conversations. Teachers then provide feedback and correct specific pronunciation issues when they arise.

According to Utami and Morganna (2022, 132-146), *shadowing pronunciation* training is a pedagogical strategy designed to enhance learners' oral proficiency by requiring them to imitate the speech of native speakers in real time. This method involves active participation in mimicking pronunciation, intonation, and rhythm while listening to a model native speaker through headphones. Effectiveness of this technique lies in the immediate feedback that allows learners to promptly adjust their pronunciation and facilitates the internalisation of authentic language expression. The strategy not only promotes native-like pronunciation, but also concurrently improves listening skills, as learners must attend closely to the nuances of the spoken language.

Language learning has been recently influenced by advancements in technology. Computer-Assisted Language Learning offers new tools and opportunities for language education in the current "digital age". Computer-Assisted Pronunciation Training (CAPT), as one of the modern pedagogical approaches, uses technology, including speech recognition software and pronunciation teaching apps. Jeong-Bae Son, in *"Computer-Assisted Language Learning: Learners, Teachers, and Tools"* (2014) discusses the evolution and impact of technology on language learning, emphasising the benefits of CAPT such as immediate feedback, support of self-directed learning, and personalised pronunciation instruction. Jeong-Bae Son (2014) likewise addresses the needs of language learners, the evolving role of teachers in technology-supported language instruction, and practical applications of CAPT.

1.2.   Pronunciation Training and Its Importance in Language Learning

Language learning is diverse and involves different skills such as reading, writing, listening and speaking, among which pronunciation plays a pivotal role in effective communication. Pronunciation is a vital element of language acquisition that extends beyond mere sound production. Achieving pronunciation proficiency, therefore, involves not only accurate articulation of phonemes, but also understanding the intonation nuances, stress patterns and rhythm.

Accurate pronunciation is the core for clear and effective communication. It enables native and non-native speakers to understand the other speakers and thereby reduces the likelihood of misunderstandings. Benati (2013, 1-13) emphasises the need for innovation in second language teaching and the importance of language teachers having a comprehensive understanding of language acquisition development. Benati highlights that teachers often lack a deep understanding of language and its acquisition process, leading to misconceptions about language learning. These misconceptions include the belief that language is learned

through studying, memorising and practising, similar to acquiring other skills. Benati (2013, 1-13) also addresses common beliefs and expectations in language teaching, emphasising the need for a shift towards evidence-based and cognitive-based pedagogical approaches.

Correct pronunciation boosts the self-confidence of language learners. Derwing and Munro (2015, 131-151) explore the relationship between pronunciation and confidence in their research and claim that individuals are more likely to engage in conversation, participate in language activities and be fully involved in the language learning process if they feel confident and comfortable and have accurate pronunciation. The authors also highlight that foreign accents are a normal consequence of second language learning and that native and non-native listeners are adept at noticing when speech differs from their own variety. Additionally, Derwing and Munro (2015, 131-151) suggest that pronunciation instruction can make a difference and that appropriate perceptual training can lead to automatic improvement in production.

O'Brien (2004, 1-9) discusses the significance of stress, rhythm and intonation in achieving a native-like accent, emphasising the importance of pronunciation training in language learning. The findings of this research revealed that native speakers focused more on stress, rhythm and intonation rather than individual sounds when judging non-native speech. It was also observed that the language environment significantly affected global pronunciation ratings, with students who studied abroad showing more improvement. The study recommends incorporating kinaesthetic exercises, *sound-symbol correspondence*, and contextualised practise to enhance pronunciation skills. Furthermore, O'Brien emphasises the importance of incorporating the pronunciation training in proficiency guidelines and the Standards for Foreign Language Learning in the 21st Century, advocating for the inclusion of intonation evaluation at lower levels and the incorporation of pronunciation into communication standards at various grade levels.

According to Thomson (2011, 744-765) is being neglected in second language (L2) instruction. Thomson (2011, 744-746) attributes this neglect to the lack of integration of research findings into pedagogical practices, particularly in the teaching of segmental units such as vowels and consonants. The failure of research to impact practice is also attributed to the gap between researchers and practitioners, as well as the limitations of learning contexts and resources available in language classrooms, which do not typically allow for the implementation of research-motivated techniques.

To address this neglect, Thomson (2011, 749-760) suggests incorporating high variability phonetic training (HVPT) into CAPT applications. This involves providing learners with increased exposure to high-quality input from multiple voices and varied phonetic contexts. Additionally, Thomson (2011, 760) recommends using platforms such as *Learning Management Systems* to design instructional resources for pronunciation instruction that incorporate high variability input and immediate feedback, which are key features of effective pronunciation training. Furthermore, Thomson (2011, 760) suggests the development of web-based applications and mobile technology to make pronunciation training more accessible to learners, allowing for remote collaboration between teachers and researchers to monitor the impact of perceptual training on pronunciation.

Pronunciation training in L2 acquisition is undeniably crucial for effective communication, confidence building and social integration. By prioritising pronunciation training, learners not only improve their ability to convey their intended messages clearly but also develop a deeper comprehension of the linguistic and sociocultural nuances of the L2. Therefore, pronunciation training should be regarded as an indispensable component of L2 learning. Clear and accurate pronunciation is crucial for effective communication, facilitating comprehension and reducing occurrence of misinterpretation.

1.3.   CAPT – Computer-Assisted Pronunciation Training

Computer-Assisted Pronunciation Training (CAPT) as an innovative approach to language instruction uses technology to assist learners in improving their pronunciation skills. CAPT is a field that has evolved significantly with the advancements in technology and language education. With its interactive and technology-enhanced feedback mechanisms, personalised learning practices, and integration with speech recognition and artificial intelligence (AI), CAPT might have the potential to transform the process of language and pronunciation acquisition.

1.3.1.   Historical Background and Development of CAPT

The early efforts in Computer-Assisted Language Learning (CALL) in the 1960's and 1970's laid the foundation for the integration of technology into language education. However, the focus during this period was on general language skills rather than specific pronunciation training (Warschauer 1996, 3-20).

The development of speech recognition technology in the 1980's and 1990's marked a significant milestone for CAPT. Researchers and developers began exploring how this technology could be applied to language acquisition, particularly in the context of pronunciation improvement (Warschauer 1996, 3-20).

According to Warschauer (1996, 3-20) the 1990's marked a growing interest in the research and development of CAPT tools. As technology improved, so did the capabilities of speech recognition systems. Increased collaboration between linguists, educators, and technologists is characteristic for this period as well.

With the expansion of multimedia and the internet, CAPT tools started incorporating video, audio, and interactive elements. This allowed for a more immersive and dynamic

learning experience. CAPT tools began incorporating principles from Second Language Acquisition (SLA) theories such as Behaviourism, environmental-oriented theories, interaction hypothesis or Connectionism (Menezes 2013, 404-412).

1.3.2. Recent Trends in CAPT Research

Various ways to make CAPT tools more personalised are being explored, taking into account individual differences in learners' pronunciation challenges. Adaptive learning algorithms aim to create and adapt exercises and feedback based on the specific needs of each learner.

Integration of artificial intelligence (AI) and automatic speech recognition (ASR) into CAPT has been on the rise. According to Rogerson-Revell (2021, 189-205) AI and ASR technologies enhance the capabilities of CAPT systems, providing learners with targeted feedback, realistic simulations, and adaptive learning methods. Natural Language Processing (NLP) techniques are applied to understand and assess pronunciation in a more nuanced way.

Mobile apps and VR technologies have been increasingly incorporated into CAPT tools, providing learners with flexibility in time and place they can practise. These mobile apps incorporate features such as interactive exercises, voice recognition technology, and personalised feedback to provide learners with a portable and convenient language learning platform. VR systems such as *Second Life* and *Active Worlds* offer immersive environments for language learners to practise in realistic scenarios and environments. This new dimension of CAPT simulates authentic conversations and adds game-like elements to create an enjoyable learning experience (Rogerson-Revell 2021, 189-205).

1.3.3. Challenges in CAPT Implementation in Language Instruction

The implementation of the Computer-Assisted Pronunciation Training (CAPT) in language teaching poses a number of challenges. These issues highlight the complexity of implementing effective CAPT tools.

Achieving high accuracy in speech recognition, particularly when taking into consideration learners' diverse accents and speech variations, remains a major challenge in implementation of CAPT. Tailoring CAPT tools to suit the individual needs of language learners and providing adaptive feedback to target their unique pronunciation difficulties is a significant challenge. Different student profiles, including different learning styles, proficiency levels and native languages, should be taken into consideration. Achieving a balance between personalised learning experience and the scalable nature of the CAPT tools in different language learning contexts appears to be crucial regarding the effectiveness of CAPT in language learning.

Bridging the gap between CAPT tools and traditional classroom instruction presents a variety of educational challenges, including time constraints and the need for smooth integration into the curriculum (Levis 2013, 177-182). Ensuring that CAPT aligns with broader language learning objectives and effectively complements in-class activities is essential for its successful implementation in the educational environment. New strategies are being developed to integrate CAPT seamlessly into existing language curricula, promoting a cohesive and supportive learning environment that combines traditional instruction with technology-enhanced pronunciation training.

Another possible challenge in CAPT implementation in language instruction is assumed to be maintaining the engagement and motivation of language learners over time. AbuSeileek (2012, 231-239) addressed the importance of overcoming potential learner

fatigue and the necessity of designing CAPT interfaces that captivate and sustain learners' interest. Innovations in instructional design, including the implementation of game-like elements, virtual reality and interactive multimedia, are expected to create more engaging and motivating CAPT experiences.

Hegadone-Bedir et al. (2023, 1619-1635) addresses ethical issues such as student data privacy (collection, analysis and communication) regarding learning algorithms. The collection and utilisation of learner data for improving technology-based learning effectiveness raise questions about responsible handling of sensitive information. Innovative approaches, including anonymisation techniques and secure data storage, are being implemented to ensure learners' personal information is protected enough while still contributing to the betterment of the technology-based learning systems. This includes promoting transparency in the use of learner data, assurance of informed consent, and efforts to reduce prejudice and create a fair and more ethical environment.

According to Rogerson-Revell (2021, 189-205) CAPT is facing a problem of many CAPT resources appearing to be technology-driven rather than pedagogy-led despite its increasing attractiveness and availability. As a result, numerous CAPT resources are pedagogically less innovative than expected. With the development of technology, occasionally seems to be retreating, moving back to audio-lingual approaches such as repetition, imitation and drilling. Rogerson-Revell (2021, 189-205) then argues that while such methods serve a purpose, they are insufficient to develop communicative or phonological competence in a target language.

1.3.4. Comparative Analysis of CAPT Tools Currently Available in the Market

In the constantly evolving landscape of language learning, the integration of technology is revolutionising pedagogical approaches and providing students with innovative tools to improve their language competences. Among these advancements, CAPT tools have emerged as an essential part of enhancing spoken language. These tools use ASR (automatic speech recognition) technology and offer learners targeted feedback on their pronunciation, thus addressing a critical aspect of language acquisition. This comparative analysis examines several prominent CAPT tools available in the market, discusses their features and functions, and offers insight into their respective strengths and areas of focus.

One notable entrant in the market, regarding pronunciation training, is the *Google Search Pronunciation* tool, which leverages its advanced speech recognition technology and benefits from Google's extensive language processing capabilities. According to Palahan (2021) users can access word definitions by typing "define" before a word and learn pronunciation by clicking the speaker icon. Palahan (2021) emphasises the option to practise pronunciation by clicking the "Learn to pronounce" icon, providing a choice between American and British accents, and highlights the effectiveness of using "how to pronounce" in the search bar. The *Google Search* pronunciation practice tool generally displays a high level of accuracy, although errors may occasionally occur, particularly in the case of non-standard accents. Conversely, The *Rosetta Stone Pronunciation* tool employs *TruAccent*, a speech recognition technology that offers precise pronunciation feedback tailored to language learners, adapting to individual accents and speech patterns (Rosetta Stone 2023).

Duolingo Pronunciation features a user-friendly interface that seamlessly integrates pronunciation exercises into broader language lessons, providing instant feedback and using a reward system to motivate learners (Duolingo 2023). On the contrary, *Babbel Pronunciation*

presents an intuitive interface with focused pronunciation exercises and provides its users with a structured approach to learning (Babbel 2023).

With regard to feedback mechanism, *Speechace* excels in providing comprehensive feedback on various aspects of pronunciation. The users receive a score alongside specific suggestions for improvement, and the platform allows for targeted practice on specific sounds (Speechace 2023). *ELSA Speak*, another notable speech analysis tool, emphasises real-time feedback to improve pronunciation, providing visualisations of pronunciation errors, and incorporating a game-based learning approach to maintain learners' attention (ELSA Speak 2023). *FluentU*, alternatively, combines pronunciation practice with authentic video content. By adapting to the user's level of proficiency of language, it presents personalised instruction that includes contextual pronunciation practice (Enux Education Limited 2022).

Numerous CAPT tools operate on a free-of-charge model, offering free versions with limited features and premium, subscription-based models that provide access to advanced functions and more extensive content. However, in evaluating the cost, it is necessary to consider the overall investment, encompassing additional language learning features beyond pronunciation offered by such tools.

1.4. Common Pronunciation Errors of Czech Learners of English

Czech learners of English frequently encounter specific pronunciation challenges with certain sounds, including difficulties with certain vowel sounds such as the /e/ and /æ/. This linguistic transition is often marked by unintentional application of native Czech phonological qualities or confusion of target English vowels with their Czech counterparts. The present common pronunciation errors, regarding /e/ and /æ/ sounds, encountered by Czech learners of English are explained and supplemented with articulatory guidance, with

the objective of providing learners with a nuanced understanding and practical strategies for refining their pronunciation skills.

1.4.1. Interchange of the /e/ and /æ/ Sounds

Language interference refers to the phenomenon where features of a learner's native language (L1) influence their acquisition or production of a second language (L2). In the context of Czech learners of English, language interference is manifested in the challenges faced by these learners in distinguishing between /e/ and /æ/ sounds.

Czech learners of English may encounter challenges distinguishing between the /e/ and /æ/ sounds, particularly due to the absence of these specific vowel distinctions in Czech and subsequently struggle to perceive them as distinct phonemes in English (i.e. The Czech learners of English may perceive these sounds as interchangeable or merge them into a single category). This interference occurs at both perceptual and productive (articulatory) levels. Perceptually, Czech learners may have difficulty identifying the subtle differences between /e/ and /æ/ sounds in English due to their similarity to certain vowel sounds in Czech language. From the productive perspective, learners may have ingrained habits from their L1 (Czech language) that later affect their production of these sounds in English (i.e. The Czech learners may have subconsciously carried over Czech lip and tongue positions when attempting to produce English /e/ and /æ/ sounds, which eventually leads to non-native like pronunciation).

The /e/ sound, found in words like "bed", "said", or "friend", involves a mid-height tongue position and slight tongue tension (Macquarie University 2020). On the other hand, the short front vowel /æ/, present in words like "man", "cat", and "land", requires a low tongue position, open mouth and unrounded lips (Macquarie University 2020).

In Czech language, the absence of these distinctions might lead learners to perceive these sounds as interchangeable. The articulatory differences are subtle, therefore Czech learners might need a focused practice to develop the ability to consistently produce and identify these specific vowels in English. Interactive language exchange activities and targeted exercises aimed at the unique features of /e/ and /æ/ sounds can be beneficial to overcome this pronunciation issue.

1.4.2. Vowel Length

Another aspect affecting the pronunciation of Czech learners of English is the tendency to elongate vowels, a feature which is typical for Czech language rather than for English. Czech learners of English might carry over the tendency to overemphasise the vowel length in English, particularly the /e/ sound (Janáková 2019, 6-10). To address this issue, incorporating exercises that emphasise the qualitative pronunciation aspects of these sounds rather than the length only might help the learners. According to Tuan (2010, 541), utilisation of minimal pairs, contrasting words with the same vowels but different lengths, can draw attention to the mentioned distinctions.

1.4.3. Lack of Diphthong Awareness

English vowels, in contrast to Czech, can form diphthongs (i.e. the produced sound gliding from one vowel to another within the same syllable) (Cambridge University Press & Assessment 2023). The lack of diphthongs in the Czech language poses another possible challenge for Czech learners of English. English vowels frequently combine to form diphthongs, a specific feature of the language to which Czech learners may not be accustomed, and therefore may subsequently pronounce English vowel combinations separately rather than blend them into diphthongs.

The most common diphthongs in English, such as those containing /e/ sound (e.g. in words such as "day" or "lake"), should be given close attention in regard to practising smooth transition between the vowel sounds within the diphthong. To overcome this challenge, learners of English may engage in targeted listening exercises, focus on the tongue and lips position, use visual aids, record oneself, and practise these sounds in contextually rich phrases and sentences, fostering a more natural and native-like pronunciation (Promova 2023).

1.4.4. Stress Patterns

Czech and English have distinct stress patterns. Czech learners of English may struggle with the variable stress patterns found in English, as Czech generally features fixed stress on the initial syllable (Palková 1994, 157). This difference may impact the rhythmic flow of English speech produced by Czech learners due to application of Czech stress patterns to English words. To address this matter, learners can benefit from activities focusing on stress and rhythmic patterns (e.g. exercises created by *BBC Learning English*). Learning the stress patterns of English through rhythmic exercises, word games, and pronunciation drills may enhance learners' sensitivity to the dynamic stress patterns characteristic of English speech. Additionally, exposure to authentic native-spoken English, such as through podcasts or other audio materials, can further reinforce an intuitive understanding of stress patterns in various contexts.

1.5. The /e/ and /æ/ Sounds and Their Articulation

The articulation of vowel sounds is a fundamental aspect of mastering any language. In English, the nuances of /e/ and /æ/ sounds play a crucial role in achieving accurate pronunciation. These vowels, despite being distinct, present a potential challenge for learners, especially those whose native language lacks these specific phonetic differentiations. Each element, from the position and tension of the tongue to the openness of the oral cavity, contributes to the distinctiveness of these particular sounds.

The /e/ sound, referred to as a close-mid front unrounded vowel (Macquarie University 2020), may be commonly found in words like "red", "head", or "pen". To articulate this sound, the tongue is positioned mid-height in the mouth, slightly raised to the palate with a moderately open oral cavity. The lips remain unrounded during the production of the /e/ sound.

On the other hand, the /æ/ sound is an open front unrounded vowel (Macquarie University 2020). This sound is involved in words such as "pan", "hat", and "black". Pronouncing the /æ/ sound correctly requires a low tongue position with an open mouth, creating a more relaxed oral cavity compared to the /e/ sound. The key distinction lies in the lower position of the tongue and the absence of tension. The lips remain unrounded, contributing to the overall openness of the vowel.

Both /e/ and /æ/ sounds play a major role in English pronunciation and may be challenging for learners, especially those whose native languages lack these specific vowel distinctions (e.g. Czech language lacks a clear differentiation between the /e/ and /æ/ sound). Practising the articulation of /e/ and /æ/ sounds separately and within words appears to be essential for learners in order to develop sufficient muscle memory and to refine their pronunciation. Minimal pairs, pairs of words varying by only one syllable, may be

particularly useful for learners of English. Contrasting words such as "pen" /pen/ and "man" /mæn/, for example, allow learners to focus on a specific vowel distinction and improve their articulation (Collins Dictionary 2023).

In conclusion, the articulation of the /e/ and /æ/ sounds not only demonstrates the complex mechanics of human speech but also reflects a broad variety of vowel systems across languages. Mastering these sounds is fundamental for language learners, as subtle differences in vowel articulation may significantly impact communication and its meaning. Understanding of the nuance of these vowel sounds contributes to the appreciation of the rich diversity found within the phonetic landscape of languages around the world.

2.   Methodology

The effectiveness of Computer-Assisted Pronunciation Training (CAPT) in language learning is receiving an increasing attention in recent years. This chapter describes the methodological framework used to investigate the effect of CAPT on the pronunciation skills of full-time undergraduate English language students at the Technical University of Liberec. The phenomena studied were narrowed down to the pronunciation of the /e/ and /æ/ vowel sounds.

The primary research question of this thesis was:

"To what extent the deficiencies in the production of the selected /e/ and /æ/ sounds can be reduced by means of computer-assisted pronunciation training (CAPT)?"

This research question aims to evaluate the effectiveness of CAPT on the pronunciation skills of non-native English speaker, focusing on the distinguishing between the /e/ and /æ/ vowel sounds. The following chapters provide a detailed description of the research design, data collection methods, participant selection criteria, specifics of the selected exercises, and data analysis procedures.

2.1.   Research Design and Approach

The study employed a targeted research design focusing on full-time undergraduate students at the Technical University of Liberec. The practical part of the research involved a creation of four electronic exercises focused on pronunciation of the /e/ and /æ/ vowel sounds supported by TUL e-learning portal. These exercises followed the "Listen-and-Repeat" method, allowing students to actively engage in pronunciation training. The research consisted of several assessment points, including pre-training, mid-training, and post-training phases, with voice recordings of a native British English speaker serving as a key metric for

evaluating the impact of CAPT on students' speech. The reason for choosing this research design was to provide a structured and controlled environment that would facilitate the assessment of effectiveness of CAPT on the specific pronunciation challenges faced by Czech learners of English.

2.2. Data Collection

Data collection involved the creation and implementation of electronic exercises and the pre-training (PT1) and post-training (PT2) recordings of students' speech. The quantitative data from electronic exercises were collected through pre-training and post-training phases, while the qualitative aspect involved the analysis of individual voice recordings at different stages of pronunciation training. The recordings of the participants' voices were obtained using the *Microphone* function found in the TUL computers. The participants subsequently uploaded recordings of their voices to the corresponding answer boxes on the TUL e-learning course which was created specifically for the purpose of this research. The combination of these methods aimed to provide a more profound understanding of the students' progression in improving the pronunciation of the target phonemes /e/ and /æ/.

2.3. Participants and Sample Selection

The sample for this study consisted of 9 full-time undergraduate students of English for Educational Purposes study programme at the Technical University of Liberec. All participants were approached with the opportunity to voluntarily contribute to the study, and an informed consent was obtained to ensure ethical research practices and to protect participants' privacy. All participants remain anonymous and are referred to for research purposes only as P1-P9 with solely their gender being mentioned. The research sample consisted of 6 female participants and 3 male participants.

2.4.   Selected CAPT Exercises

The participants took part in a 90-minute session, completing 4 pronunciation exercises in total which included minimal pairs, phonemic transcription, "drag-and-drop" matching exercise and tongue twisters. All the mentioned exercises concerned distinguishing between /e/ and /æ/ sounds. The exercises were provided on TUL e-learning portal.

A pre-test (PT1) was conducted before exercises mentioned above. This test was later used for further evaluation of an improvement in pronunciation of each student involved in the study. The pre-test (PT1) consisted of a short text created specifically for this study, including various instances of /e/ and /æ/ sounds. The participants were presented with the text at the very beginning of the session without being informed in advance that the study focuses on /e/ and /æ/ sounds in order to make the participants' speech natural and deliberately not focused on certain sounds.

After completion of the 4 pronunciation exercises, the participants were presented with the identical text to that of PT1. The participants were asked to read the post-test (PT2) text again, make recordings of their voice, and upload these recordings on TUL e-learning course. The post-test (PT2) consisted of 12 instances of /æ/ sound, and 9 instances of /e/ sound evaluated, in this case highlighted. The participants therefore intentionally focused on the 21 instances mentioned above during their speech. Pre-test (PT1) and post-test (PT2) recordings of each participant were subsequently used to evaluate the possible improvement in the participants' pronunciation of the /e/ and /æ/ sounds.

Record yourself reading the following text **again**, this time make sure to **focus** on the highlighted words.

Sally sells pans and pens. It is an unusual business as you could have guessed already, but she makes a decent salary. Her husband owns a gas station in the town. In the span of the last two weeks he spent most of the time in his bed. It is a bad situation. He injured his leg when he tripped over the rack and now he is a nervous wreck. Sally said her man looks sad lately. Hopefully, he will get better soon. All he can do now is to watch their black cat sitting on a mat by the window and eat his favourite strawberry jam.

Figure 1: Example of a Text Used in PT2

3.   Data Analysis

Data analysis consisted of the collection and examination of pre-test (PT1) and post-test (PT2) recordings of each participant. An auditory assessment (AA) of PT1 and PT2 was conducted first to subjectively evaluate the participants' pronunciation and possible improvement between PT1 and PT2. The auditory assessment was evaluated by listening to a recording of the analysed word recorded by a native British English speaker. Subsequently, the native speaker's recording was compared with the participant's recording. A match or mismatch between the participant's recording and the native speaker's recording was, for the sake of clarity, marked OK or NG (as in *Table 1* for PT1 and *Table 2* for PT2). The phonetic transcription of the correct pronunciation of the given words according to standard British English pronunciation and the student's pronunciation were recorded in the *Table 1* and *Table 2* for comparison.

   Full records of AA and PRAAT measurements are available in an attached document "BP_Halamkova_Appendix". For illustrative purposes, observations and values for one of the participants only are mentioned in the body of the thesis.

Analysed word	Correct pronunciation	Student's pronunciation	Auditory assessment
Sally sells pans (...)	/sæli/	/seli/	NG
Sally _sells_ pans (...)	/selz/	/selz/	OK
Sally sells _pans_ (...)	/pænz/	/penz/	NG
Sally sells pans and _pens_.	/penz/	/penz/	OK
(...) as you could have _guessed_ (...)	/gest/	/gest/	OK
(...) but she makes a decent _salary_ (...)	/sæləri/	/seləri/	NG
Her husband owns a _gas_ station (...)	/gæs/	/ges/	NG
In the _span_ of (...)	/spæn/	/spen/	NG
(...) he _spent_ most of the time (...)	/spent/	/spent/	OK
(...) most of the time in his _bed_.	/bed/	/bed/	OK
It is a _bad_ situation.	/bæd/	/bed/	NG
He injured his _leg_ (...)	/leg/	/leg/	OK
(...) he tripped over the _rack_ (...)	/ræk/	/rek/	NG
(...) now he is a nervous wreck.	/rek/	/rek/	OK
Sally said her man looks sad lately (...)	/sed/	/sed/	OK
Sally said her man looks sad lately (...)	/sæd/	/sed/	NG
Hopefully, he will get better soon.	/betə/	/betə/	OK
(...) to watch their black cat (...)	/blæk/	/blæk/	OK
(...) to watch their black cat (...)	/kæt/	/ket/	NG
(...) their black cat sitting on a mat (...)	/mæt/	/mæt/	OK
(...) eat his favourite strawberry jam.	/dʒæm/	/dʒem/	NG

Table 1: Auditory Assessment PT1 – Student 1 (Female)

Analysed word	Correct pronunciation	Student's pronunciation	Auditory assessment
Sally sells pans (...)	/sæli/	/seli/	NG
Sally _sells_ pans (...)	/selz/	/selz/	OK
Sally sells _pans_ (...)	/pænz/	/pænz/	OK
Sally sells pans and _pens_.	/penz/	/penz/	OK
(...) as you could have _guessed_ (...)	/gest/	/gest/	OK
(...) but she makes a decent _salary_ (...)	/sæləri/	/seləri/	NG
Her husband owns a _gas_ station (...)	/gæs/	/gæs/	OK
In the _span_ of (...)	/spæn/	/spæn/	OK
(...) he _spent_ most of the time (...)	/spent/	/spent/	OK
(...) most of the time in his _bed_.	/bed/	/bed/	OK
It is a _bad_ situation.	/bæd/	/bæd/	OK
He injured his _leg_ (...)	/leg/	/leg/	OK
(...) he tripped over the _rack_ (...)	/ræk/	/ræk/	OK
(...) now he is a nervous _wreck_.	/rek/	/rek/	OK
Sally _said_ her man looks sad lately (...)	/sed/	/sed/	OK
Sally said her man looks _sad_ lately (...)	/sæd/	/sæd/	OK
Hopefully, he will get _better_ soon.	/betə/	/betə/	OK
(...) to watch their _black_ cat (...)	/blæk/	/blæk/	OK
(...) to watch their black _cat_ (...)	/kæt/	/ket/	NG
(...) their black cat sitting on a _mat_ (...)	/mæt/	/met/	OK
(...) eat his favourite strawberry _jam_.	/dʒæm/	/dʒæm/	OK

Table 2: Auditory Assessment PT2 – Student 1 (Female)

The results of the auditory assessment might have been distorted considering the subjective evaluation of the accuracy of the participants' pronunciation. For this reason, an analysis via *PRAAT* software followed the auditory assessment.

Before PRAAT software measurements, several adjustments were made regarding the formant settings. The PRAAT spectrogram required settings for male or female voices according to the gender of the participant as shown in *Figure 2*. The formant setup was followed by PRAAT analysis of the selected words for each participant.
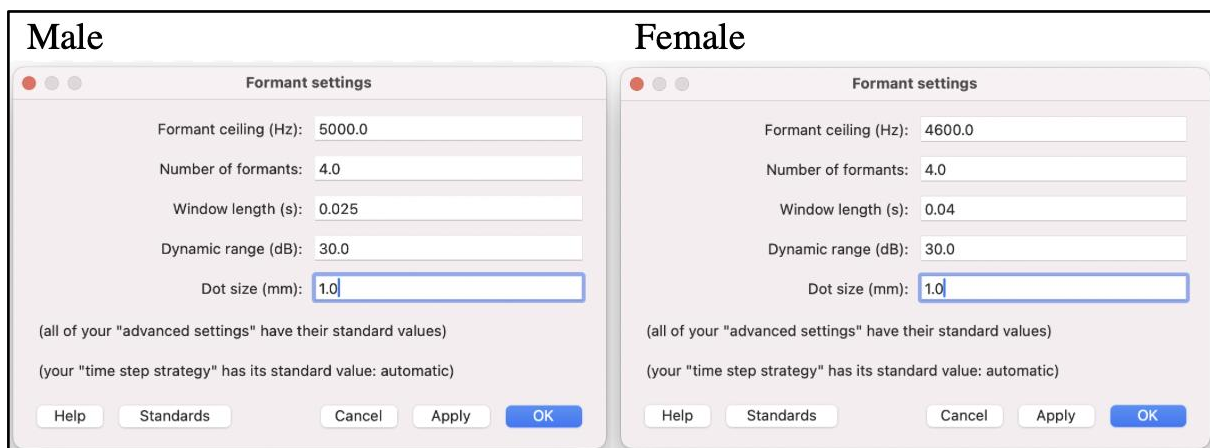

Figure 2: PRAAT Formant Settings for Male and Female

The PRAAT analysis was based on the data obtained from *Formant 1* (F1), a value inversely related to vowel height, which provided a frequency (in Hz) determining the phonetic quality of /e/ and /æ/ sounds. The participants' audio-recordings were cleaned from background noises via *Audacity* software for the reason of the research being conducted in a school environment rather than in a laboratory equipped by specialised research conditions and audio-processing technology. The PRAAT analysis data were assessed as "OK" and "NG" as well according to the standard F1 frequencies for RP pure vowels found in *Figure 3*.

	F_1		F_2	
	Male	Female	Male	Female
/iː/	280	303	2249	2654
/ɪ/	367	384	1757	2174
/e/	494	719	1650	2063
/æ/	690	1018	1550	1799
/ʌ/	644	914	1259	1459
/ɑː/	646	910	1155	1316
/ɒ/	646	751	1047	1215
/ɔː/	415	389	828	888
/ʊ/	379	410	1173	1340
/uː/	316	328	1191	1437
/ɜː/	478	606	1436	1695

Figure 3: (Cruttenden 2001, 100): Formant Frequencies for RP Pure Vowels in Connected Speech

The average F1 value (in Hz) was calculated for the assessment of the PRAAT analysis. From the sample of 21 words examined, three words for /æ/ and three for /e/ sounds whose pronunciation was closest to that of a native speaker within AA were selected for each participant. From the selected values, the arithmetic mean was subsequently calculated for the /e/ and /æ/ sounds. The referred value is shown in the *Table 3* under the title "Average value of F1 (Hz)". The "Average value of F1" was compared to the value measured in PRAAT software (i.e. with column "Measured value of F1") and was assessed as "OK/NG". The mentioned values used for calculation of the "Average value of F1" were taken solely from PT2, since for this part of the CAPT it was assumed that participants would pronounce the given words more accurately than in PT1.

Analysed word	Average value of F1 (Hz)	Expected value of F1 (Hz)	Measured value of F1 (Hz)	Assessment
Sally sells pans (...)	915	1018	746	NG
Sally _sells_ pans (...)	761	719	815	OK
Sally sells _pans_ (...)	915	1018	762	NG
Sally sells pans and _pens_.	761	719	850	OK
(...) as you could have _guessed_ (...)	761	719	764	OK
(...) but she makes a decent _salary_ (...)	915	1018	687	NG
Her husband owns a _gas_ station (...)	915	1018	902	OK
In the _span_ of (...)	915	1018	846	NG
(...) he _spent_ most of the time (...)	761	719	808	OK
(...) most of the time in his _bed_.	761	719	857	OK
It is a _bad_ situation.	915	1018	957	OK
He injured his _leg_ (...)	761	719	821	OK
(...) he tripped over the _rack_ (...)	915	719	819	OK
(...) now he is a nervous _wreck_.	761	1018	774	NG
Sally _said_ her man looks sad lately (...)	761	719	795	OK
Sally said her man looks _sad_ lately (...)	915	1018	854	NG
Hopefully, he will get _better_ soon.	761	719	773	OK
(...) to watch their _black_ cat (...)	915	1018	829	NG
(...) to watch their black _cat_ (...)	915	1018	843	NG
(...) their black cat sitting on a _mat_ (...)	915	1018	886	NG
(...) eat his favourite strawberry _jam_.	915	1018	854	NG

Table 3: AA vs. PRAAT Analysis PT2 – Student 1 (Female)

The "Average value of F1" was calculated for each participant individually due to the fact that, unlike the measurements that determine standard values for RP pure vowels (in *Figure 3*), the measurements for this research were not conducted in a scientific setting with professional sound analysis equipment. Thus, the audio recordings were of degraded sound quality and the values measured in the PRAAT software occasionally showed considerable discrepancies with the standard values stated in *Figure 3*.

The "Expected value of F1" column in *Table 3* lists the F1 value (in Hz) found in *Figure 3* for the /e/ and /æ/ sounds. This value is included in the table for comparison of the "Average value of F1" with the standard values shown in *Figure 3*.

The range for "OK/NG" in *Table 3* assessment was 100 Hz above or below the "Average value of F1" frequency. The data approaching a higher value (measured in Hz) indicated a low vowel (such as /æ/) and conversely the data approaching a lower value in Hz signified a high vowel (such as /e/) as in *Figure 4*.
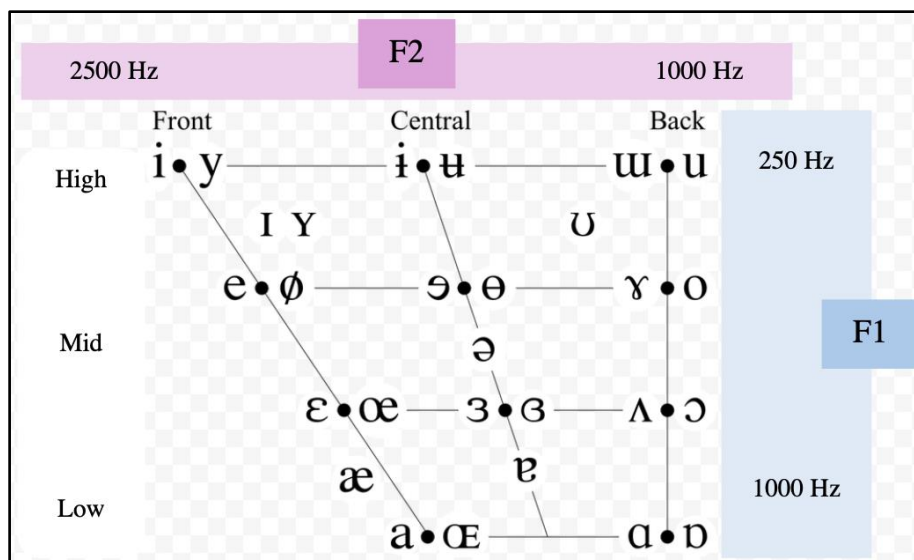

Figure 4: IPA Vowel Chart with Formants

Analysed word	Average value of F1 (Hz)	Measured value of F1 (Hz) – PT1	Assessment
Sally sells pans (...)	915	780	NG
Sally *sells* pans (...)	761	780	OK
Sally sells *pans* (...)	915	845	OK
Sally sells pans and *pens*.	761	834	OK
(...) as you could have *guessed* (...)	761	599	NG
(...) but she makes a decent *salary* (...)	915	710	NG
Her husband owns a *gas* station (...)	915	612	NG
In the *span* of (...)	915	758	NG
(...) he *spent* most of the time (...)	761	713	OK
(...) most of the time in his *bed*.	761	771	OK
It is a *bad* situation.	915	764	NG
He injured his *leg* (...)	761	753	OK
(...) he tripped over the *rack* (...)	915	794	NG
(...) now he is a nervous *wreck*.	761	805	OK
Sally *said* her man looks sad lately (...)	761	718	OK
Sally said her man looks *sad* lately (...)	915	758	NG
Hopefully, he will get *better* soon.	761	632	OK
(...) to watch their *black* cat (...)	915	768	NG
(...) to watch their black *cat* (...)	915	780	NG
(...) their black cat sitting on a *mat* (...)	915	888	OK
(...) eat his favourite strawberry *jam*.	915	719	NG

Table 4: PRAAT Analysis PT1 vs. PT2 – Student 1 (Female)

Table 4 shows a comparison of the PRAAT analysis from PT1 and PT2. The column "Average value of F1" in this table refers to the values obtained from the AA during PT2, being based on the same principle as in *Table 3*. The "Average value of F1" was compared to the "Measured value" (i.e. F1 value from PT1) and was assessed as "OK/NG" with a range of 100 Hz above or below the "Average value of F1".

The data from auditory assessment (PT1) and auditory assessment (PT2) were subsequently compared reciprocally (see *Figure 6*) to determine to what extend has the participants' pronunciation audibly improved between the PT1 and PT2. Auditory assessments from both PT1 and PT2 were afterwards compared to frequencies measured in PRAAT software (see *Figure 7*). Finally, the PT1 and PT2 values measured in the PRAAT software were compared (as shown in *Figure 8*) with each other to attain the most objective results regarding possible improvement in participants' pronunciation.

3.1.1. PRAAT Software

PRAAT software is an open-source tool used mainly for phonetic and acoustic analysis of speech sounds developed by Paul Boersma and David Weenik from the Institute of Phonetics Sciences of the University of Amsterdam in 1991 (Boersma, 2001, 341-347). According to Boersma (2001, 341-347) the PRAAT software is based on the spectral, formant, pitch and intensity analysis of the sounds, offering further key features such as speech synthesis or segmentation of audio recordings.

The PRAAT software was chosen as a linguistic research tool for this thesis to investigate and analyse speech sounds and their acoustic characteristics, providing visual feedback on participants' pronunciation. The *Figure 5* depicts the PRAAT Spectrogram window with a vowel sound highlighted in red and the F1 location.
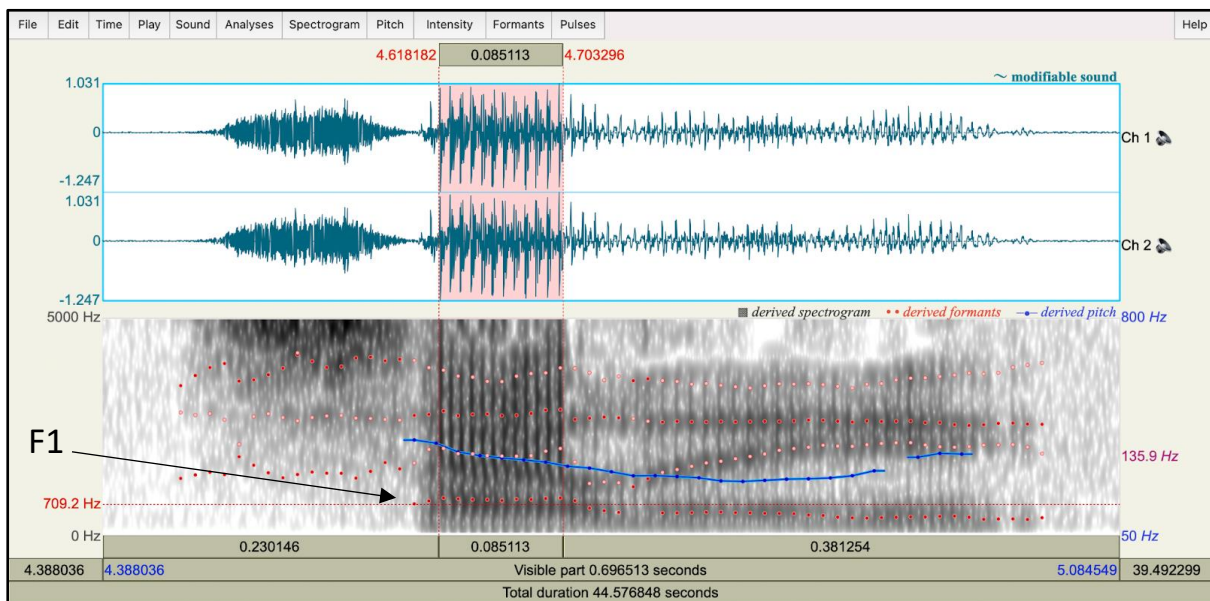

Figure 5: PRAAT Spectrogram

3.1.2. Comparison of Pre-training and Post-training Pronunciation Scores

This study aimed to evaluate the effectiveness of the CAPT conducted via TUL E-learning portal. The participants were asked to complete 4 CAPT exercises preceded by pre-training (PT1) and followed by post-training (PT2). Both pre-training and post-training were based on reading of a short text shown in the *Figure 1*. The participants were not informed in advance about the concerns of the research to maintain their natural speech patterns. After completing all 4 CAPT exercises, the participants were asked to read the same text as in PT1. In this case, the participants were presented with the text including highlighted words that should be brought to their attention during the reading and speech recording. From a total of 21 instances evaluated, 12 words included the /æ/ sound and 9 included the /e/ sound.

The first comparison is focused primarily on the values acquired from the auditory assessment for both PT1 and PT2 compared to the values measured in PRAAT software. From 9 research participants, 8 showed an improvement in their pronunciation according to the subjective auditory assessment (AA). One student was evaluated to have an invariable pronunciation of the instances mentioned during the AA.
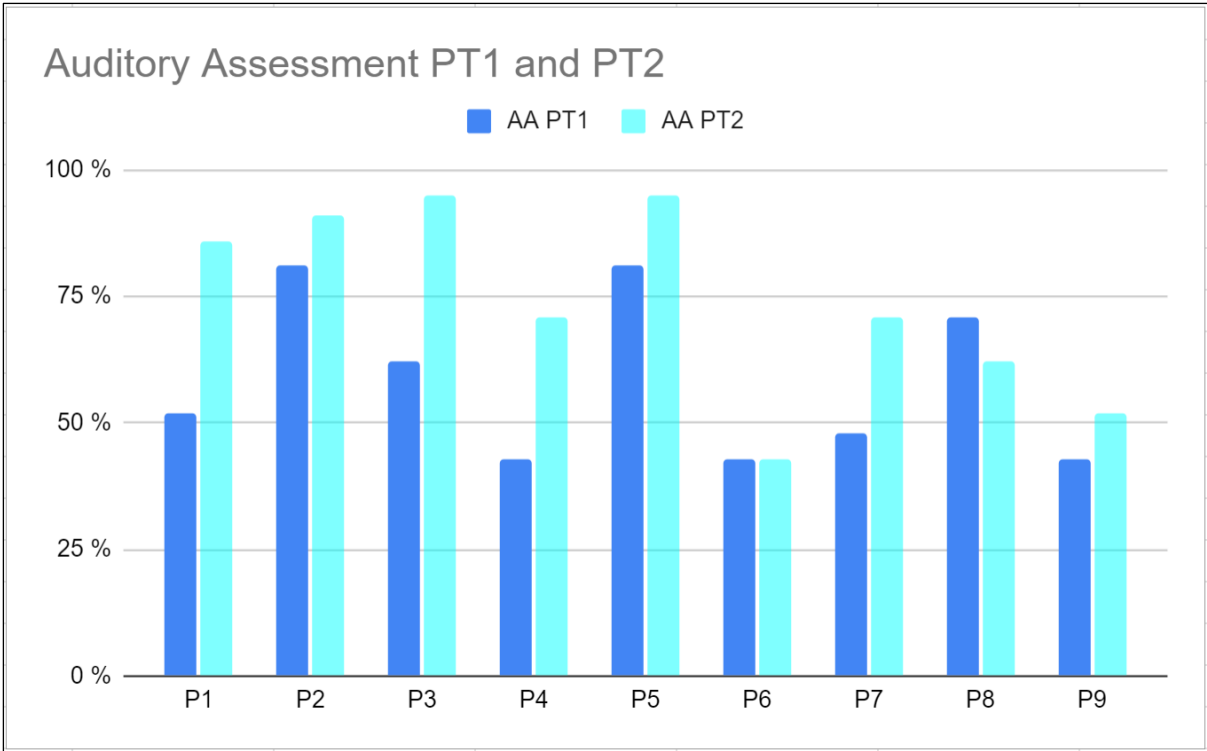
Figure 6: Comparison 1 – AA PT1 vs. PT2

In comparison with PRAAT measurements, the results slightly vary from the AA. The PRAAT analysis showed that 6 of 9 participants demonstrably showed an improvement in their pronunciation of the /e/ and /æ/ sounds as shown in the *Figure 7*. The graphs shown in *Fig. 6 - Fig. 8* show only the cases in which the instances /e/ and /æ/ were pronounced correctly (i.e. for the sake of clarity, only the values that were evaluated as "OK" are depicted).
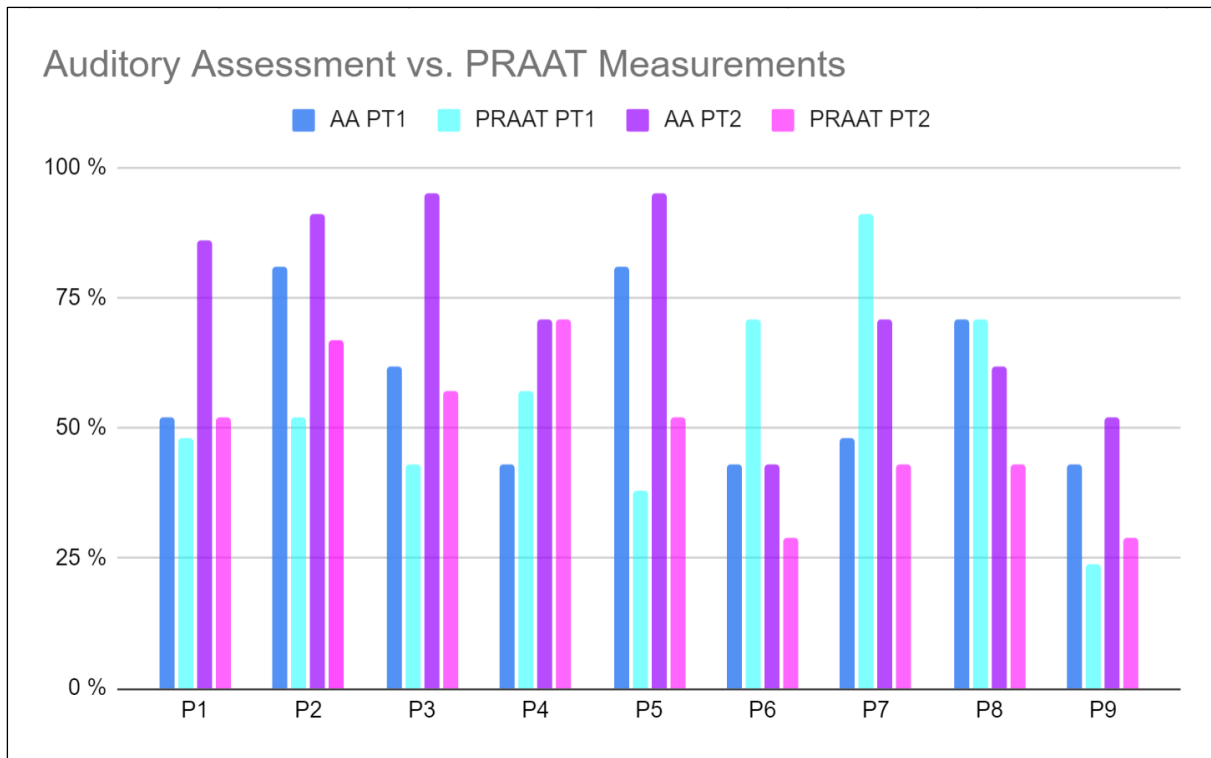
Figure 7: Comparison 2 – AA vs. PRAAT Measurements

A comparison of the PRAAT analysis of PT1 and PT2 offers a more objective perspective. In PT1 measured in PRAAT, 6 out of 9 participants pronounced more than 50% of the instances correctly. From 9 participants in total, 6 demonstrably improved their pronunciation of the /e/ and /æ/ sounds in the PT2. However, pronunciation of the /e/ and /æ/ sounds deteriorated noticeably in case of 3 participants (*Figure 8*) according to the values measured in PRAAT.
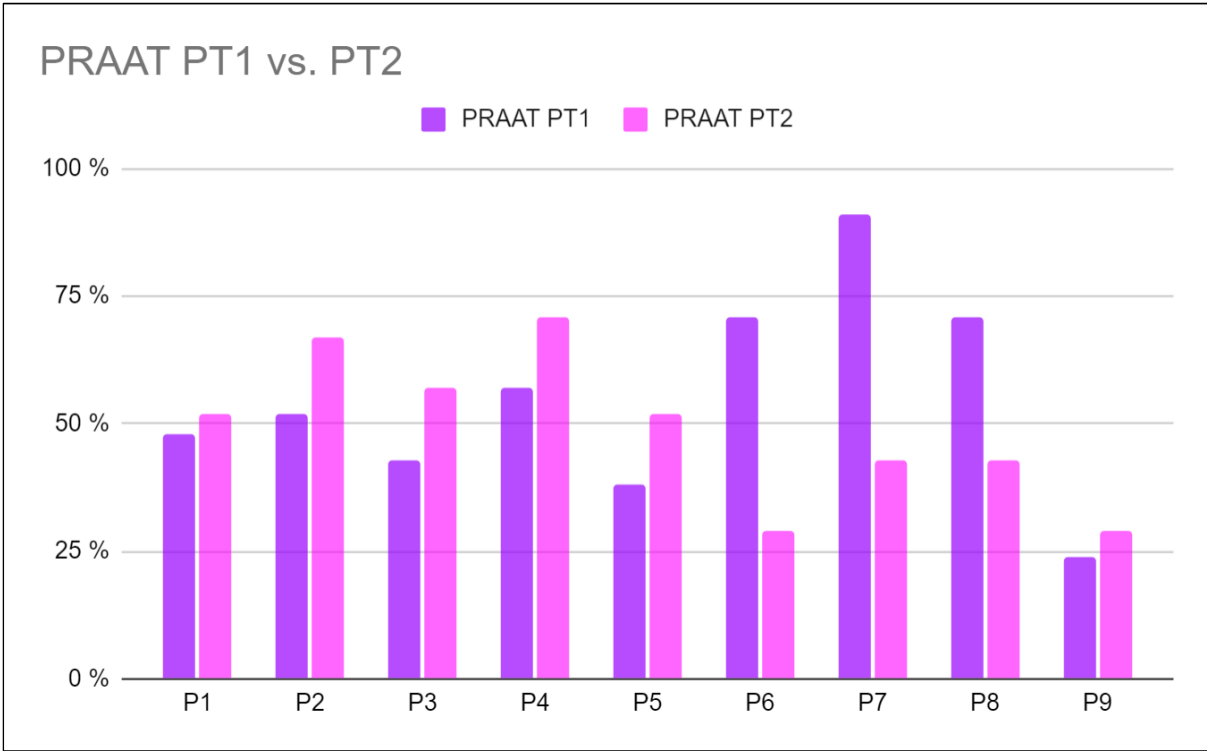
Figure 8: Comparison 3 – PRAAT PT1 vs. PT2

4.   Results

The primary objective of this research was to examine and evaluate the effectiveness of a Computer-Assisted Pronunciation Training (CAPT) on the pronunciation skills regarding the /e/ and /æ/ sounds. A total of 9 Czech TUL undergraduate students of a study programme English Language for Educational Purposes participated in a 90-minute CAPT session, completing four pronunciation training exercises preceded by PT1 (pre-test) and followed by PT2 (post-test). PT1 and PT2 were based on the participants reading a short text while recording their speech. The text from PT1 and PT2 was identical, including 12 evaluated instances of /æ/ sound and 9 instances of /e/ sound.

Key findings of the research indicate an improvement in pronunciation of /e/ and /æ/ sounds among 6 of 9 participants after undertaking the CAPT exercises from which 4 improved their pronunciation for at least 14%. Comparing PT1 and PT2 scores, it was observed that the majority of participants improved their pronunciation during the CAPT session. However, pronunciation of 3 participants in fact worsened during PT2 as measured in PRAAT software.

This result might be due to the fact that the session was held for 90 minutes and therefore some participants might have stopped being as attentive at the end as they were during the PT1 part. Patterns in the results suggest that the majority of participants repeat the pronunciation error of not distinguishing between the /e/ and /æ/ sounds in several words even after completing all the exercises with a native speaker serving as a pronunciation model before the participants recorded their speech.

However, despite the positive results, the values used to assess the correctness (measured in Hz) of the participants' pronunciation were taken from a source that works with values measured in a scientific setting, and thus the results of this research may be slightly biased. Furthermore, the participants underwent a rather short CAPT. In order to observe a more significant improvement, the participants would have needed to undergo considerably longer and regularly repeated pronunciation training.

5.   Discussion

The use of the CAPT for English language education might have several significant implications, particularly in helping non-native English learners distinguish between challenging sounds such as /e/ and /æ/. This research has shown that pronunciation training is often neglected in English language instruction and learners might therefore seem to struggle with sounds that are often not present in their native language. This was also the case in this research, during which the participants were subjected to a CAPT efficiency test aimed at differentiating between /e/ and /æ/ sounds.

The research has shown that the participants in most cases made improvements in their pronunciation of /e/ and /æ/ after having participated in a single CAPT session. It is likely that if participants underwent similar training on a regular basis, their pronunciation could improve even further. This demonstrates that CAPT programmes, if included in English language instruction, could hold great potential in the future. CAPTs can provide exercises specifically designed to help English learners distinguish between similar sounds or the sounds not present in their native language. Furthermore, CAPT exercises provide an immediate and consistent feedback, offering learners to see and hear the features of particular sounds simultaneously, which reinforces the correct pronunciation.

CAPTs are adaptable to diverse learning styles of the learners, which is essential for effective language instruction. It was ensured that the participants in this research had enough time for their answers and that they could listen to the recordings of the native speaker multiple times if needed. The exercises used for the research offered learners an interactive environment, auditory models and immediate feedback on their pronunciation or answers. Future research in this field may be directed more towards innovations in CAPT systems that adapt according to individual progress, offer personalised exercises, and target an individual's specific pronunciation problems.

Increased learners' confidence represents another important benefit of CAPT. Such pronunciation training allows learners to practise their pronunciation privately, reducing the pressure that might be placed on them in a classroom setting. The private practice environment might encourage learners to practise more frequently and gradually accomplish more difficult tasks.

In addition to students, language teachers might benefit from the interaction of CAPT into the curriculum as well. CAPT based programmes such as *ELSA Speak* or *Speechace* offer learners interactive pronunciation exercises, auditory models, and immediate feedback (with all of the aforementioned features being available in the exercises for this research as well), promoting an effective language instruction and reinforcing correct pronunciation in an entertaining way. Such programmes may serve as noteworthy supplementary tools that allow teachers to focus on various aspects of language teaching while students work independently on improving their pronunciation. This balanced use of classroom time could lead to more effective language learning. In addition, CAPT systems generate data that teachers may use to identify common pronunciation difficulties among students, allowing for more targeted and effective teaching strategies. CAPTs nor only promote autonomous learning, reinforce habits of self-monitoring and self-correction, but also may motivate learners to continue to use CAPT tools for constant improvement even after formal instruction has ended.

Conclusion

This bachelor thesis was aimed to investigate the effectiveness of Computer-Assisted Pronunciation Training (CAPT) on the pronunciation skills of Czech learners of English, focusing specifically on the distinction between the vowel sounds /e/ and /æ/. The research was conducted at the Technical University of Liberec among 9 full-time undergraduate students of the English language for Educational Purposes study programme. Through a series of targeted CAPT exercises, the research focused on evaluating the improvement in participants' pronunciation accuracy.

The research question to be answered was as follows:

"To what extent the deficiencies in the production of the selected /e/ and /æ/ sounds can be reduced by means of computer-assisted pronunciation training (CAPT)?"

The research findings are conclusive and demonstrate the potential of CAPT as a beneficial tool in language instruction. The majority of the participants showed noticeable improvement in their ability to distinguish and produce /e/ and /æ/ sounds correctly. This improvement was evident both in the subjective auditory assessment and the objective PRAAT software analysis. The results indicate that 8 out of 9 participants exhibited an improvement in their pronunciation according to the subjective auditory assessments, with 6 participants showing improvement according to the data obtained from the PRAAT software.

These results underscore the importance of targeted and repetitive exposure to pronunciation training. The "Listen-and-Repeat" method applied in the CAPT exercises allowed the participants to actively engage with the phonetic distinctions between /e/ and /æ/ sounds, leading to a more accurate pronunciation of the sounds mentioned. Combined with the immediate feedback provided during the CAPT session, this methodological approach

seems to have played a significant role in the observed improvements in the participants' pronunciation.

The research also highlights the challenges faced by Czech learners in mastering the English phonetic system. The absence of the /æ/ sound in the Czech language makes the distinction between sounds /e/ and /æ/ particularly difficult for Czech learners of English. However, the results of this research suggest that with a focused training, these challenges could be surpassed. This is an encouraging outcome for language teachers and learners alike, as it indicates that pronunciation skills can be demonstrably improved through dedicated and structured pronunciation training.

It is important to note that while the research demonstrates the effectiveness of CAPT, the sample size was relatively small, and the duration of the training was limited to a single 90-minute session. Future research could explore the long-term effects of CAPT over a more extended period and with a larger participant group. Additionally, further studies could investigate the impact of CAPT on other aspects of pronunciation and language learning, such as intonation, rhythm, and overall fluency.

Secondary observations have shown that the auditory assessment is significantly consistent with the PRAAT measurements. Although, in real-life situations pronunciation is not assessed using speech recognition software. During a conversation, the subjective perception of speech and comprehensive pronunciation is much more relevant. Thus, this paper also highlights the fact that AA values showed a greater degree of improvement in pronunciation over PRAAT measurements.

In conclusion, this thesis provides compelling evidence that CAPT can serve as an effective method for improving the pronunciation skills of non-native English speakers. The research findings suggest that CAPT has the potential to enhance learners' ability to produce specific sounds accurately, and thus improving their overall pronunciation and communication skills in English. The implications of this research for language education are significant and offer a promising pathway for incorporating technology into pronunciation instruction to facilitate better learning outcomes.

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Appendix

The full text of the appendix is available in the attached document "BP_Halamkova_Appendix.pdf".