Design and development of a mobile game for music education in primary schools

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Abstract

This research addresses the need to enhance the efficiency of 5th-grade music classes, a pivotal component in a child's elementary education, where students first encounter a professional music teacher. The study's goal is to develop a mobile game application aimed at making it easier for 5th-grade students to acquire competencies in listening, singing, musical perception, knowledge, music culture, and musical creativity, while also fostering a greater love for music and enjoyable learning. In pursuit of this goal, the research employs the Design and Development Research (DDR) method, a scientific research approach. It features six different games allowing students to learn note sounds and positions, match instrument images with their sounds, develop rhythm skills, engage in a multiple-choice quiz about music culture, guess the instrument associated with a sound they hear, and play the drums and xylophone creatively. This application aims to present 5th-grade music curriculum topics engagingly, enabling students to practice and learn from anywhere while promoting long-lasting understanding. In conclusion, the "Music Marathon" mobile game was designed and developed with the expectation of offering 5th-grade students a fun way to learn music concepts from their curriculum, practice anytime and anywhere, and achieve lasting comprehension.

Keywords: Educational software; mobile game; music teaching; technology

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1. Introduction

In today's world, advancing technologies, particularly mobile devices, have become an integral part of our lives. With easy access to information, people rely on their mobile devices throughout the day for various tasks. Various programs (applications) are available in stores designed for mobile applications. These applications are categorized under various headings, including socialization, finance, entertainment, games, and education, with thousands of applications in each category. Mobile technologies empower students to personalize their learning processes, provide learning opportunities based on real-world experiences, encourage collaborative learning, and support informal learning beyond the confines of formal educational institutions, free from time and location constraints (Cheon et al., 2012).

The renowned developmental psychologist, Jean Piaget, famously stated that "play is the work of children," highlighting the potential of games to support learning (Cohen, 2007; as cited in Wilkinson, 2016). Games not only complement traditional teaching methods but also nurture skills like rule compliance, adaptability, problem-solving, critical thinking, creativity, teamwork, and sportsmanship (Zirawaga et al., 2017; Li et al., 2022). Mobile learning, particularly through mobile games, can provide users with an effective learning environment anytime and anywhere (Pitteri et al., 2021; Videnovik et al., 2023; Toh & Lim 2022).

Gaming, a part of human life since time immemorial, has taken on a different dimension with the advent of computers. Professions related to computer gaming, such as video game design, have become remarkably popular today. Especially from a young age, children spend enjoyable moments playing games on mobile devices like tablets and phones. As Jane McGonigal, an expert in game design, pointed out in her 2010 TED talk, "In a country with a strong gaming culture, an average young person today will have spent 10,000 hours playing games online by the time they reach 21." If we can capture the essence of fun in games that captivate these young individuals, who spend over a year of their lives in a virtual world of entertainment, we can use it to introduce and teach anything we desire (O'Donovan, 2012; Udeozor et al., 2023).

When examining the application stores of Android and iOS-based devices, it becomes evident that there is a multitude of music games and applications available. These applications have been thoroughly scrutinized, revealing that a significant number of them become paid after reaching a certain level, indicating a commercial purpose. Additionally, many of these applications contain only a single educational element. Music's structured and programmatic inclusion in children's education is crucial for nurturing the talents of musically inclined children and making a contribution to society's future. In this context, the primary education level, especially, stands out as a critical stage of education (Senturk, 2009).

1.1. Purpose of the Research

This research aims to develop a mobile game that allows 5th-grade elementary school students to enjoy themselves while improving their knowledge of music through playing. The researcher has designed a mobile-based educational game software for 5th-grade students, emphasizing both educational and enjoyable approaches in music education. The goal is for students to become familiar with essential music education concepts, such as music notes, musical symbols, rhythms, time values, music compositions, musical terminology, music genres, and instrument types, in a fun and engaging way through games, thus enabling experiential learning.

Due to the opportunities provided by technological advancements, students have the chance to enhance their learning processes and self-improvement by using mobile applications and playing educational games. This approach allows students to recognize and address conceptual gaps, increasing their active participation and potentially positively impacting their academic achievements. The software, by presenting visual and auditory elements at the highest level, has the potential to make the music education process more efficient. Such an approach can assist teachers in managing the educational process more effectively and help students enjoy a more beneficial learning

experience. In today's world, where children grow up with technology and use it extensively in their daily lives, the use of such applications in education is becoming increasingly important. Upon investigation of available applications in the stores, no application was found that offers versatile use within the music game/education category. Therefore, the Music Marathon game is considered important for addressing this gap.

2. Method and materials

This research aims to develop a mobile game application for 5th-grade elementary school music classes to be used as an instructional aid. In line with this, the Design and Development Research (DDR) method, one of the scientific research methods used to create educational software, was employed. In the field of educational technology and instructional design research, Richey and Klein (2007) specifically recommend the use of the Design and Development Research (DDR) method. This method can be applied not only in research focused on the development of products, tools, materials, and software in both natural and social sciences but also in research aimed at model and process development. However, it is worth noting that the Design and Development Research Model (DDR) is particularly recommended for research in the field of instructional design and technology (Buyukozturk et al., 2016). Design and Development Research can be categorized into two main types: Type-1 and Type-2. Type-1 research is concerned with the development of products and tools, while Type-2 research focuses on the creation of design and development models (Richey and Klein, 2007, as cited in Buyukozturk et al., 2016). This research is classified within the Type-1 category of the DDR model as it encompasses the "design," "development," and "evaluation" stages within an Android and IOS-based application, which is software aimed at music education through music games.

3. Results

3.1. Mobile Game Application: Music Marathon

To be used in music education, the Music Marathon game developed with the Unity game engine features six different game categories designed to provide students with various learning domains of music and their respective achievements. To be able to use the Unity game engine, the researcher took a 6-month course in Unity game development and the C# programming language and collaborated with a professional assistant during the game development process. The game's graphical user interface (GUI) elements, sprites (graphic images to be displayed in the game), backgrounds, animations, and sound elements consist of paid and free licensed products collected by the researcher. The process of gathering the game's elements, designing and developing the game, identifying and rectifying errors, searching for new errors, and resolving them repeatedly, as well as uploading it to the Google Play Store and AppStore, took an average of 3 months. In the design phase, decisions made and updated during the game development process aimed to teach the game's visual and audio elements, notes, various instruments, their sounds, rhythm, and fundamental rhythmic skills. The game also enhances basic knowledge of music theory and terminology and includes virtual instruments for improvisation. Some aspects of the game evolved differently from the initial concept during the design process and were refined as the process advanced.

3.2. Home Screen

The game offers 6 different game options, providing students with various gaming experiences. It also includes additional features, such as a "How to Play" button for learning how to use the game and a "High Scores" button for recording players' highest scores.

3.2.1. 6 Different Games

The game begins with the main entry screen, featuring buttons representing 6 different games. These games offer students a variety of gaming experiences, allowing them to choose the game of

their preference. These games are, in order: "Music Field," "Instrument Hunter," "Catch the Rhythm," "Music Expert," "I Recognize This Sound!" and "Let's Play."

3.2.2. How to Play

This button assists players who want to learn how to play each game by providing information about the rules and gameplay instructions for each game.

3.2.3. High Scores

This button enables players to record their highest scores in the games they've played. As a result, players can keep a record of their best performances and share these scores with friends and teachers.

These features enhance the effective use of the game, offering students the opportunity to learn the games and compete. Additionally, the "High Scores" section can motivate students to track their scores and strive to achieve their goals.

Figure 1
Home Screen – "How to Play" tutorial and "High Scores" Button.

3.3. Music Field

The game features essential elements related to the main character, opponents, and castles as follows:

Main Character: The character controlled by players aims to defeat opponents by correctly selecting the basic music notes and recognizing colored notes.

Notes: These represent the music notes students need to learn, and they are presented using color coding (for example, C (red), D (orange), E (yellow), F (light green), G (dark green), A (blue), B (purple), High C (red)).

Opponents: When a player guesses the notes incorrectly, the opponents cause point deductions and progressively speed up with each wrong answer. If a player correctly identifies the note, the opponent is disqualified, and the player earns 10 points. As levels progress, the number and speed of opponents increase.

Level Endings: When a player reaches the end of a level, they face a level-ending castle. This section requires players to wait until they correctly answer a level question. When the castle question is correctly answered, a "GOAL!" animation and crowd cheers are heard, and buttons are activated for the next level. The player can advance to the next stage by clicking the forward button, practicing listening to note sounds without losing points or playing simple melodies on the note buttons.

Health Points (HP): Players lose points when they mark a note incorrectly, and opponents' approach more quickly. If the treble clef is passed, one of the player's lives is deducted.

Soccer Goal: The soccer goal is a character that awaits the player's response to a level question at the end of each level. If the player answers the question incorrectly, they lose points, and the goal speeds up. If the soccer goal touches the player, all of the player's health points are done. Depending on the soccer goals's proximity, the main character shoots at three different heights, high, low, and mid.

Score: The player's score is calculated based on correctly known notes and answers to questions. The player earns 10 points for each correctly identified note and loses 10 points for every incorrect click.

Levels: The game consists of a total of 11 levels, with each level being more challenging than the previous one. As levels progress, the number of opponents and their speeds increase.

The game's purpose is to provide students with an opportunity to develop their note-reading abilities and learn music in a fun way. Students learn the locations of notes on the staff by practicing on the stave and enhance their musical ear by listening to the sounds of the notes they click. Players who complete all levels receive a "Bravo, You've Learned the Notes" message and their achieved score.

This game is designed to support music learning and the acquisition of note-reading skills, offering students an enjoyable learning experience.

Figure 2
 Music Field Game
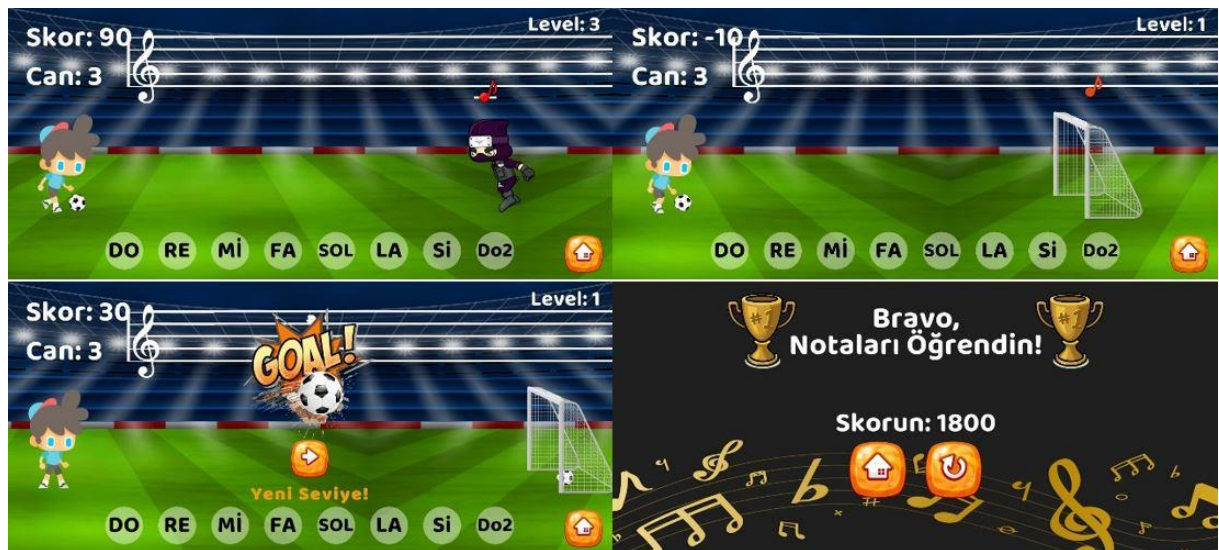
3.4. Instrument Hunter

This game is a card-matching game that provides students with an opportunity to recognize musical instruments and learn the sounds of these instruments. The basic features of the game are as follows:

Gameplay: Players click on cards to match them and learn the names and appearances of the instruments on each card.

Learning Objectives: The game aims to help students recognize musical instruments, learn the names of the instruments, and familiarize themselves with the sound of each instrument.

Number of Cards and Levels: The game starts with 4 cards, and the number of cards increases with each new level. There are a total of 11 levels, with 24 cards visible in the final level.

Scoring: Players earn 10 points for every successful match. However, they lose 2 points for incorrect matches.

Time: Players must match all the cards within a specific time. Each match adds 5 seconds to the time, and more time is given as levels progress.

Mistake Tolerance: The game allows for a certain margin of error, and players can make incorrect matches, but this results in a point deduction.

Sounds: When players make a correct match, they listen to the sound of each instrument, which enhances their sound recognition skills.

Success Screen: For players who complete the game, a message reads, "Well Done! You Finished the Game! You've Learned All the Sounds."

This game aims to help students recognize musical instruments, learn their sounds, and enhance their memory skills. It is designed to assist music enthusiasts in strengthening their musical knowledge.

Figure 3
Instrument Hunter Game
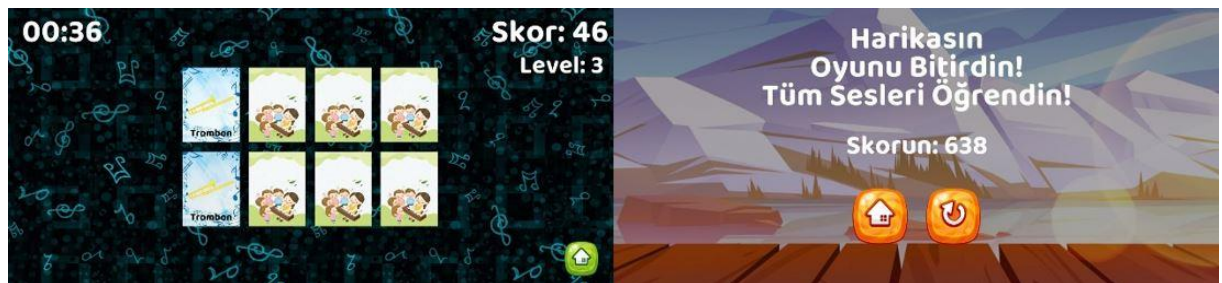
3.5. Catch the Rhythm

The game "Catch the Rhythm" is an educational game that provides students with the opportunity to recognize rhythm patterns in different time signatures and make rhythmic beats at the right time. In the level selection section, players can access general information about note values by pressing the "i" button. The fundamental features of the game are as follows:

Time Signatures: Players listen to various melodies and rhythm patterns that include time signatures like 4/4, 4/3, and 4/2, and they try to execute rhythmic beats at the right time.

Rhythmic Beats: Players click on or hold down the drum button on the screen at the correct times to make rhythmic beats, depending on the note value.

Levels and Stars: The game consists of a total of 50 levels. To pass each level, players need to earn at least 1 star. Correct rhythmic beats are indicated in green, while incorrect beats are marked in red.

Difficulty Levels: Players can initially choose the game's difficulty level (easy, medium, hard). Each difficulty level offers a different tempo (bpm) option (easy: 60bpm, medium: 90bpm, hard: 120bpm).

Earning Stars: The star-earning system is based on the player's performance. 0 or 1 mistake earns 3 stars, 2 or 3 mistakes earn 2 stars, and 4 or 5 mistakes earn 1 star. Players who make 6 or more mistakes have to repeat the section.

Note Values: The game includes various note values (whole notes, half notes, quarter notes, eighth notes) and their corresponding rests.

Success Screen: For players who complete the game, a message reads, "Congratulations! You're now a Rhythm Master." At the end of each passed level, a window with options to proceed, replay, or exit opens.

This game provides an entertaining and educational experience for students who want to enhance

their rhythm skills. Players have the opportunity to develop their sense of rhythm while learning different time signatures.

Figure 4
Instrument Hunter Game
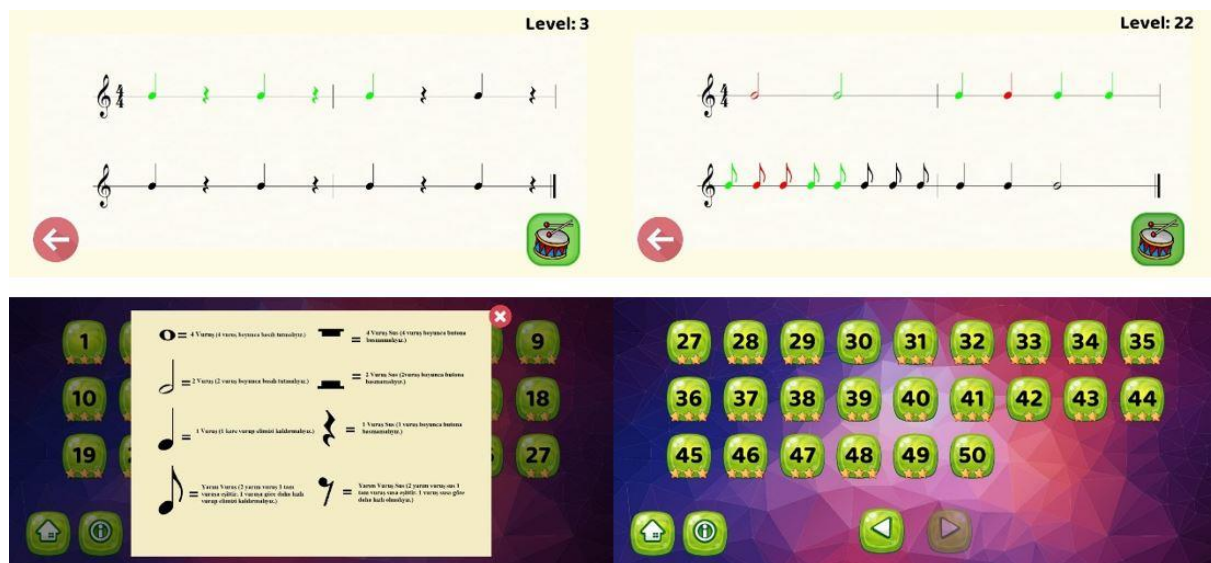
3.6. Music Expert

The game "Music Expert" is a knowledge quiz that asks students questions about various music topics and offers different lifeline options. The features of the game are as follows:

Question Types: The game includes questions related to various music topics such as general music theory, music culture, notes, signs, musical compositions, and music genres. Additionally, the game also features image-based and audio-based questions.

Lifelines: Players can gain an advantage in answering questions by using lifelines. The lifelines are as follows:

Audience Lifeline: Provides a 60% chance of giving the correct answer.

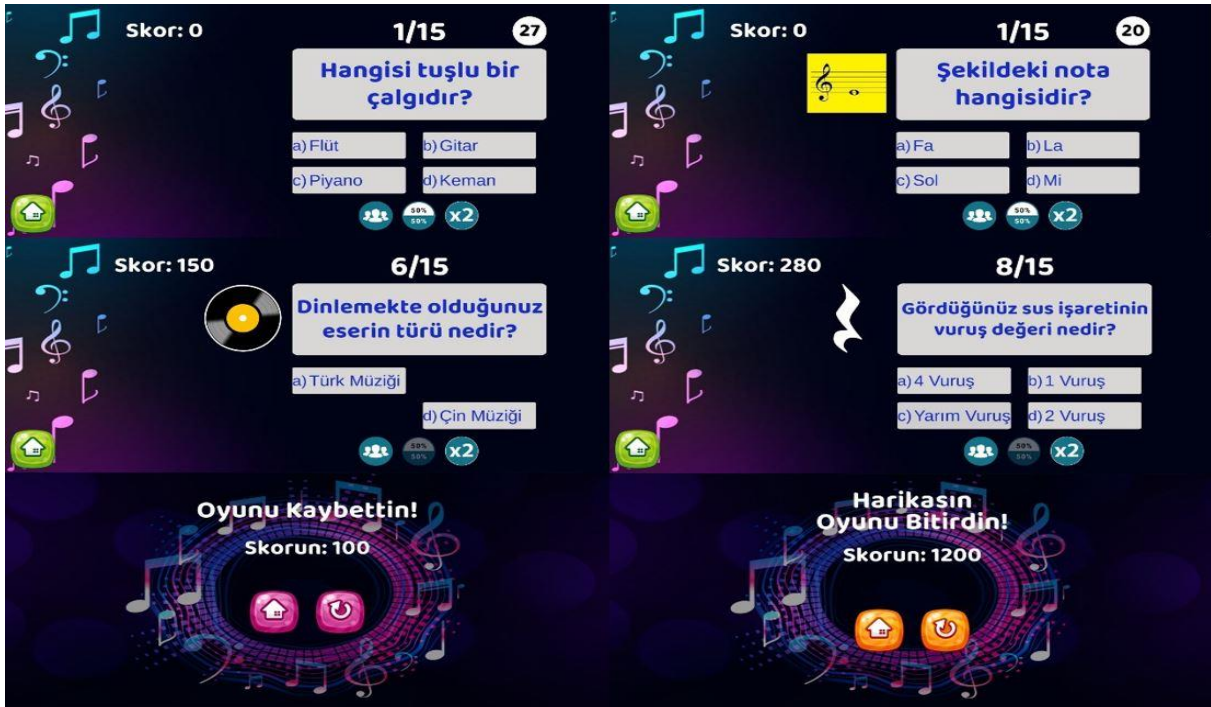*50/50 Lifeline:* Helps eliminate two random wrong answers.

Double Answer Chance: Allows players to answer the question with two answer options.

Number of Questions: The game has a pool of 80 questions. In each gameplay session, 15 randomly selected questions are presented to the players.

Game Mechanics: The first 5 questions have a 30-second time limit for each question, but there is no time limit for the subsequent questions. If players answer 15 questions incorrectly before completing them, they lose the game. However, the points they have earned up to that point are recorded on the scoreboard.

This game offers an enjoyable and educational experience for students who want to test and enhance their music knowledge. Players can test their knowledge and strategies by answering various music-related questions and using different lifeline options.

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Figure 5

Music Expert Game

3.7. I Recognize This Sound!

The game "I Recognize This Sound!" is designed as a game that aims to reinforce the sounds students learned in the "Instrument Hunter" game and helps them recognize the sounds of different instruments. Here are some features of the game:

Instruments: The game starts with 2 buttons, and as players provide correct answers, more instrument options become available. There is a total of 26 different instrument options. In the final level, all 26 different instruments are displayed on the screen at the same time.

Difficulty Levels: At the beginning of the game, players are presented with easy, medium, and hard options. Each option offers a different level of difficulty, and the countdown times vary. In the easy mode, players are given more time, while in the hard mode, they have less time. Easy mode allows 6 minutes, medium mode allows 4 minutes, and hard mode allows 2 minutes.

Scoring System: Players earn points by providing correct answers. After each correct answer, their points are doubled. In the easy mode, the game starts with 10 points, in the medium mode with 20 points, and in the hard mode with 30 points. Incorrect answers reduce the remaining lives but do not affect the score.

Health Points (HP): Players have 3 lives due to incorrect answers. When all 3 lives are used, the game ends, but the points earned up to that point are recorded on the scoreboard.

The primary goal of the game is to help students develop their musical ears and recognize the characteristic sounds of various instruments. The game aims to motivate students by offering different difficulty levels and reward mechanics. Students try to earn high scores by providing as many correct answers as possible within the specified time.

Figure 6
I Recognize This Sound! Game
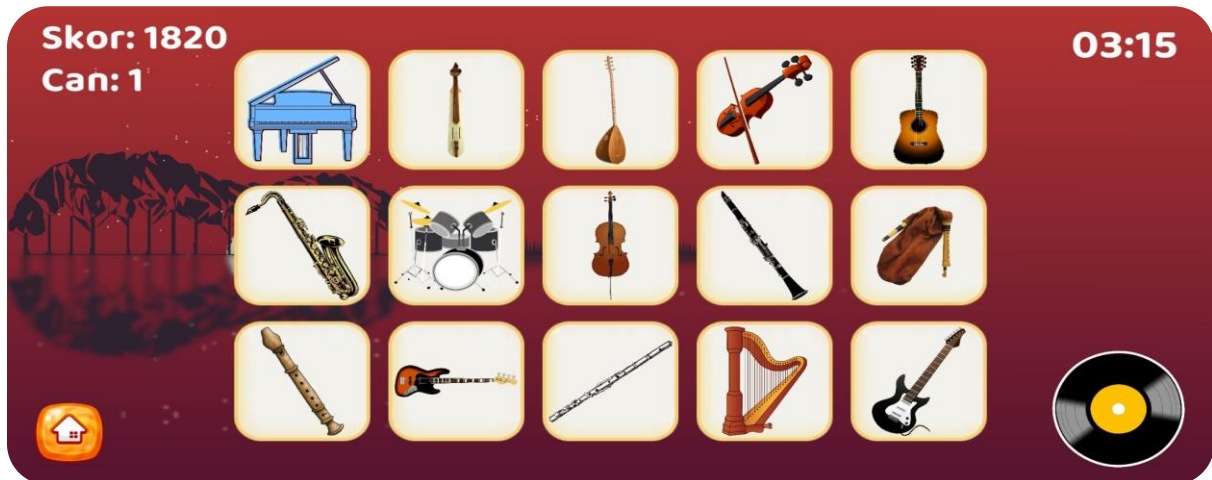
3.8. Let's Play

The "Let's Play" game is meticulously designed to offer students an opportunity to explore music and freely develop their instrumental skills. The game incorporates the following features:

Instrument Selection: At the beginning of the game, students have the choice to select either the xylophone or the drums as their preferred instrument.

Accompanying Songs: Throughout the game, students can accompany classroom songs using their chosen instruments. This aids in enhancing their ability to harmonize with songs and develop melody extraction skills.

Free Play: Students are allowed to spend free time within the game, during which they can play their instruments as they desire. This free period encourages spontaneous musical improvisation.

Enhancing Musical Skills: Using their selected instruments, students can create rhythms and play song melodies, fostering the development of their musical abilities.

The primary objective of this game is to provide students with the opportunity to explore music and develop their musical talents. This game has the potential to increase students' interest in music and encourage them in their self-guided journey of learning music. It contributes to the enjoyable and creative learning of music.
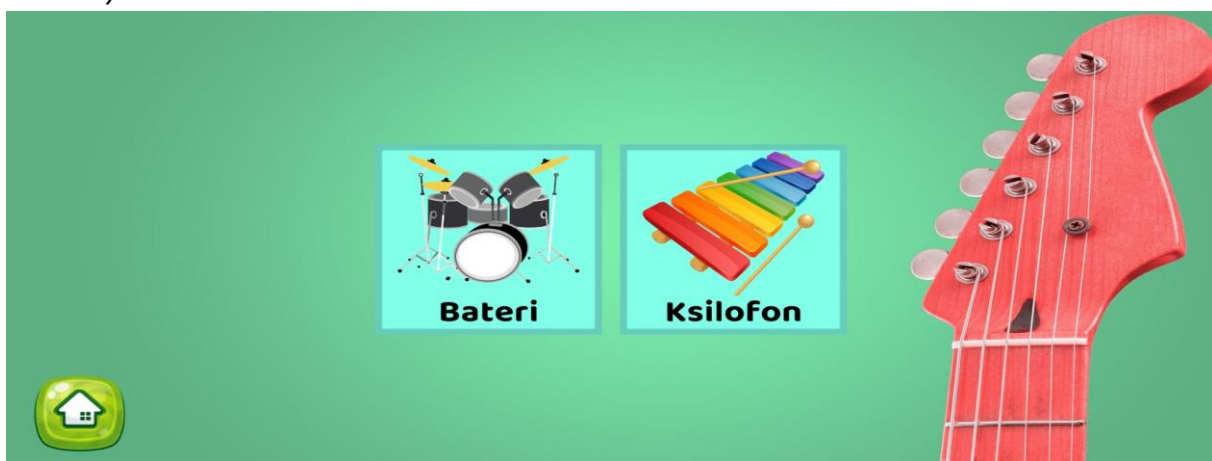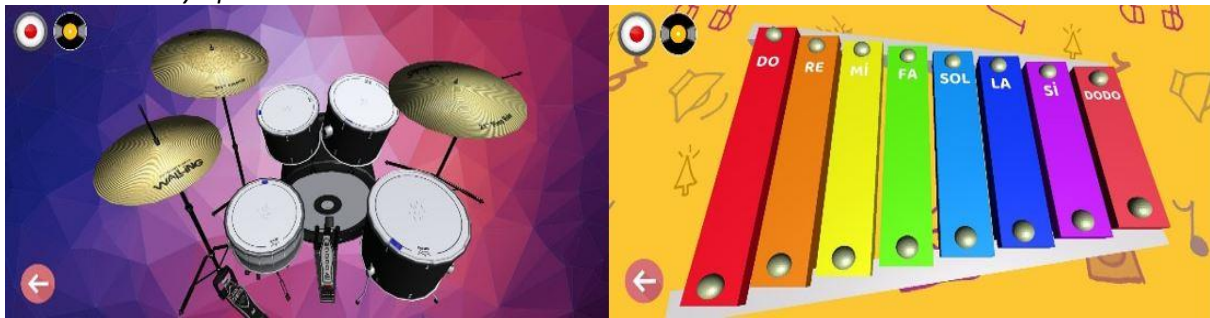
Figure 7
Let's Play Game

Figure 8
Drum and Xylophone

4. Discussion

The "Music Marathon" game offers students the opportunity to explore various aspects of music, providing an enjoyable pastime in both classroom and home settings. The game's entertaining structure and motivation for playing can enhance the learning process. As playing the game successfully requires a certain level of music knowledge, it's likely to stimulate students' desire to acquire this knowledge.

Especially with traditional methods, learning the positions and names of notes on the musical staff is facilitated interactively for students through this game. Additionally, for students who may not have the opportunity to hear the sounds of notes, this application can assist them in learning by listening to the sounds of notes. The game content offers a range of activities, such as recognizing different instruments, practicing various rhythms, participating in music knowledge quizzes, and accompanying songs with musical instruments. This variety provides students with the opportunity to explore and learn about different aspects of music.

Various studies have demonstrated the positive impact of mobile learning on music education. A research study conducted with 6th-grade primary school students found that the use of mobile music games both in class with teachers and independently outside of school hours allowed students to rapidly, easily, and enjoyably grasp music concepts such as rhythm, note values, letter notation, and the location of notes on the piano through the experimental process (Uludag & Satir, 2023). In their study, Tsai et al., (2017) implemented a quasi-experimental design to investigate the effect of student motivation on achievement using a mobile game-based English learning approach. They developed a system named "Happy English Learning System" that integrated learning materials into a game-based context and installed it on mobile devices to experiment. The experimental period spanned 8 weeks and was applied to 38 Taiwanese vocational high school students. The results, obtained through statistical methods, confirmed the positive effectiveness of the approach in enhancing students' motivation and achievement in English. The study also indicated that students' learning motivation partially predicted their English achievement. This study offers various positive recommendations for English learning and teaching in Taiwanese vocational education. Okumus Dagdeler (2023) and Nagaletchimee et al., (2023) emphasized also in their research, the role of mobile technology in learning vocabulary at a high dissension and assimilation rate.

From this perspective, the "Music Marathon" game offers a fresh perspective on music education at the primary school level. In an era marked by rapid technological advancement, there is a growing belief in the need to incorporate technology more extensively into education. Both students and teachers must adapt to this change and utilize technology more effectively in the educational process.

5. Conclusion

The mobile game application developed for music classes can be accessed on Android and iOS devices, facilitating its use both during lessons and outside of class. Particularly at the primary school

level, music classes often have limited time, which poses challenges for students in grasping fundamental elements of music, notably reading sheet music. This game application addresses this issue by offering students a more engaging and enduring approach to learning music.

Games host a range of challenges, from decision-making and problem-solving strategies to testing one's reflexes (Kosmadoudi et al., 2013). The developed game allows for the reinforcement and practical experience of the information provided in music classes. Consequently, it offers students an opportunity to engage with music beyond the limited time constraints of music lessons, allowing them to interact with music during their free time. By playing the game, students have the chance to delve deeper into their understanding of music. Moreover, this game's structure promotes practice, even in subjects that typically require rote memorization. Students are required to continually apply specific concepts and persistently attempt them again, even if they make mistakes, to advance in the game. This supportive approach enhances the learning process and strengthens fundamental musical skills.

As a result, this developed game application can be effectively utilized as an educational tool, particularly in elementary school music classes. It provides students with more practical and experiential opportunities while learning the fundamental elements of music, making the process of learning music more enjoyable and effective.

6. Recommendations

Within the scope of the research, the following recommendations have been put forth:

• This application has been developed for 5th-grade elementary school students. By adding more advanced levels and different topics, applications can be developed for different grade levels, or the existing application can be updated.

• With this application, quantitative research comparing traditional teaching methods and game-based instruction can be conducted through experimental or quasi-experimental studies in schools.

• The opinions of music teachers and students taking music classes can be gathered using this application.

• Additional questions, instruments, sounds, levels, and sections can be added to the games.

• Specific songs for the drums and xylophone can be uploaded to enable collaborative playing of these songs.

• Versions of the game in different languages can be produced to reach a wider audience.

• This application, developed for music classes, can be integrated into other subject areas, creating separate applications for each subject and grade category or a broader integrated application.

The researcher plans to implement these recommendations in future studies.

The application is downloadable from the links below:

Android: https://play.google.com/store/apps/details?id=com.UgurKartal.MuzikMaratonu

IOS: https://apps.apple.com/us/app/m%C3%BCzik-maratonu/id6467564902

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