# Innovative Piano Pedagogy for the 21st Century Learners

## Integration of Modern Technologies in the Teaching Process

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**Abstract**

The twenty-first century has been marked by a growing interest in the use of technology, including in education. Music education is not an exception. Nowadays students and teachers are showing increasing enthusiasm in using digital tools. They effectively integrate them into their teaching and learning practices. Consequently, traditional methods of teaching piano are being complemented by digital resources that meet the diverse needs, learning styles, and preferences of modern students. This study explores innovative approaches in twenty-first century piano pedagogy with a primary focus on the integration of modern technologies. The aim of the study is to examine how technology can be used to personalize piano instruction, improve accessibility, learner engagement, and motivation. The research focuses on educational applications, online platforms, and the use of artificial intelligence in classical piano education.

The main goal of the study is to expand the opportunities of piano teachers and students by introducing new practical tools into teaching methodologies. The use of timely real-time feedback, interactive software, game-based methods, self-study educational programs, and distance learning lessons aims to improve the learning process. It helps to transform it into an interactive, engaging, and effective experience. This study is based on an analysis of case studies and the collection of opinions from experts in the field, as well as teachers and students. The study demonstrates the benefits of integrating digital tools into both formal and informal learning.

The research findings revealed that effective integration of technology can increase student motivation, encourage creativity, and support the development of independent learning skills across different age groups and ability levels. At the same time, the study also highlights the significance of preserving human interaction, artistic expression, and pedagogical sensitivity in the context of piano teaching. These outcomes provide practical recommendations and solutions for integrating technology into teaching practices, thereby laying the foundation for innovative pedagogical strategies that meet the needs of today's learners.

**Keywords/tags (subject)**

Piano Pedagogy, Educational Technology, Digital Tools in Music Learning, Interactive Learning Technologies, Modern Teaching Methods, Music Learning App, Innovative Teaching Strategies, Music Pedagogy and Technology Integration

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# 1 Introduction

Piano pedagogy can be defined as an intensive, complex, and multifaceted process encompassing a variety of educational strategies and teaching approaches. The objective of a piano pedagogue is to nurture the growth of students' cognitive, emotional, physical, and social skills (Neuhaus, 1987, p. 148). These vital skills are formed in childhood and consolidated as a lifelong skill. In this context, this study focuses on new approaches and resources in piano pedagogy that contribute to the formation of the student's personality and the development of these competences.

The twenty-first century has been characterized by the leap and rapid development of technology. Consequently, changes in everyday life naturally lead to changes in the system and methodology of education. The great American educator, philosopher, and educational reformer John Dewey stated a century ago: “If we teach today’s students as we taught yesterday’s, we rob them of tomorrow” (Ross, 2017, para. 3). In response to this statement, the additional purpose of this study is to investigate the relevance of emerging technologies and their application in classical piano teaching. In order to motivate students and spark their interest in classical music, a modern teacher needs to master new forms and methods of teaching. A contemporary educator should know how to use the latest technical means, information technology, and the possibilities of global network in music education. A student becomes not an object but an active subject of learning.

As a result, this study examines the growing need for transformative and progressive approaches to piano teaching in the twenty-first century. The research is directed towards piano teachers as well as their students and aimed to provide practical tools, equipping and introducing them to the latest technological innovations in piano teaching at the time of study conducting. The main focus has been made on school-age students and young adults, who are often the primary users of digital learning resources and the most receptive to the use of technology in learning.

In the second chapter of this study, the author introduces the reader to the fundamental concepts of classical piano education, based on the writings of well-known pedagogues. This

methodological foundation serves to comprehend the principles of piano pedagogy and to explore the potential of technological integration to enhance the teaching and learning process.

The third chapter describes the research objective, justifies its relevance, and formulates the main goal and research question, as well as research strategy, data collection methods and the reliability and validity of the results. The fourth chapter forms the centre of the study. The author directly engages with technological findings and details the circumstances in which their application is appropriate. This encompasses the utilization of Disklavier, online platforms, educational resources, game software and applications, along with the integration of artificial intelligence, a contemporary innovation in music education. The fifth chapter shares the findings and conclusions of the study. It includes feedback from the expert, as well as the personal experiences, feelings, and opinions of educators and students who use technological resources in practice. The final chapter summarizes the findings of the study and provides further recommendations.

An important aspect is that the study considers technology not only as a pedagogical tool, but also in a broader context within the framework of sustainable development, both social and environmental. The use of digital tools increases accessibility and equality in education, which determines social sustainability. An example of this is distance learning when necessary. In terms of environmental sustainability, the balance is considered between the potential reduction in travel and printed materials and the energy consumption, lifespan of devices, and e-waste associated with digital technologies. Economic sustainability is also considered, focusing on the rational use of resources, including price thresholds for equipment and prioritizing the use of tools that genuinely enhance educational value, rather than the introduction of technology for its own sake. Thus, the study recognizes not only the pedagogical significance of technology integration but also its broader social responsibility and impact.

No relevant source has been found that deals so comprehensively with the use of technology in classical piano pedagogy, as this is a modern and understudied phenomenon. There is an increasing demand for research in this area, and the results of this study aim to significantly contribute to the development of piano pedagogy in different aspects, as well as increasing the interest and motivation of today's students.

# 2 Overview of Piano Pedagogy

Pedagogy, particularly in art, requires both deep knowledge and skills, as well as the ability to think creatively about the learning and teaching process (Barysheva, 2021, p. 16). The creative approach ensures deeper and more comprehensive student development, establishes a solid foundation, and at the same time, makes learning exciting and productive (Ross, 2017, para. 1). In the context of piano teaching, the individual approach to the student is demonstrated in sensitivity and flexibility. The teacher adapts individual methods and materials according to each student's abilities, interests, and goals. This requires the application of a variety of approaches rather than relying on a single method. According to Neuhaus (1987, p. 147-148) the diversity of methods employed by a teacher varies depending on their professional experience, pedagogical training, and the individual needs of each student. Consequently, teachers select and combine methods to motivate students and create an engaging and pedagogically effective learning process.

Learning to play the piano is a complex process. Worschech et al. (2024, pp.1-2) assert that numerous factors influence the development of a student's pianistic, cognitive, physical, and musical skills. These elements shape students' pianistic technique and musical understanding. The history of piano art and pedagogy is long and rich. This chapter will examine the fundamental aspects of piano pedagogy based on pedagogical literature and consider how contemporary technologies may support and enhance the teaching and learning process.

## 2.1 The Emergence of a Personal Connection with Music

At the beginning of a planned piano lesson, the teacher's role is often to establish a connection with the student, introducing them to the piano and music in general. This is an interesting and challenging role. According to Thompson (2018), the primary objective of the teacher is not to simply transfer musical knowledge and skills. Instead, their main function is to engage the students and stimulate their interest in music. Barysheva (2021) emphasizes that the teacher introduces the student to the poetic image of the piece by explaining its content, providing a comprehensive analysis, and describing its structure, paying close attention to every musical detail. Contact with sound, as well as physical and emotional contact with the instrument is considered an essential beginning to musical education.

According to Thompson (2018), the formation of musical and auditory perceptions occurs in the initial stages. The student progresses to demonstrate artistic thinking, imagination, and associations with music. The involvement in a new learning process is accompanied by active emotional responsiveness to musical impressions. This individual and natural connection to music forms the basis for meaningful music teaching (Thompson, 2018, pp. 5–7).

The author suggests that at this stage of acquaintance with the instrument and musical sounds, the following digital tools can be used to assist the teacher:

- educational music learning platforms
- associative music games
- additional audio and video lessons

## 2.2 Principle of Consistency

Consistency in teaching is important in learning activities (Jacobson, 2006, p. 8). Learning the piano is not an exception to this. The integration of cognitive, physical and emotional processes demands logical sequencing to optimize learning effectiveness. Progression through new material is founded upon the solid base of previous knowledge. The following example explores what a student encounters while playing the piano:

1. When playing from sheet music, the student must first comprehend the notation and then demonstrate the ability to reproduce the music. In this context, theoretical knowledge and physical skills are integrated.
2. Playing with two hands develops coordination skills gradually and consistently.
3. The student listens to his or her playing, paying attention to the evenness of the sound.
4. The student conveys a musical idea, and ultimately, plays the piece from memory.

This is a clear and simple example of the initial training level. Later on, this list will be supplemented with the mastery of the pedal, the interpretation of the stylistic features of the piece, the development of technical and musical skills, and the establishment of an appropriate tempo. The principle of consistency from simple to complex applies not only to technical difficulty but also to the scope of the piece, its musical language, and its content (Barysheva, 2021, pp. 20–22). All of these components should gradually increase in complexity. It is also important to consolidate the material at each level.

In light of this concept, digital games designed for the purpose of music education can provide significant assistance to educators. Frequently, such games are characterized by a range of levels of difficulty. Therefore, the sequential principle of learning, in particular theoretical knowledge, can be successfully applied.

## 2.3 Music Reading Skill

The ability to read sheet music is among the initial musical competencies that students encounter, representing a fundamental step in their musical education. Musical text can be compared to a musical language, a kind of communication tool (Miranda, 2022). Students learn to read it, interpret, and express it through their performance. The skill of reading musical text involves more than just reading notes. It also involves understanding various elements such as pitch, melodic direction, character, tempo, timbre, register, articulation, rhythm, and dynamics. With time, through consistency in study, as the skill of reading musical text is consolidated, the students begin to perceive in the notes a multitude of details. It includes the structure of the composition, its style, historical function, the composer's vision, tempo markings, texture, and signs of expression. In this way, the notes are subsequently perceived as if they were letters folded into words, phrases into sentences, parts into clauses, and the whole piece as an interesting story into a thrilling adventure (Musicnotes, 2024).

As posited by Miranda (2022), the act of interpreting musical notation demands the engagement of cognitive and physical competence. Visual comprehension of the text prompts a transformation and reproduction through coordinated movements on the piano. This process evidently requires much training and experience, based on the principle of simple to complex.

The essence or mechanics of fluent reading of both book and musical text are centered on the following (CalPolyPomona, 2024):

- wide eye coverage of phrases without fixation on a single word or short segment
- the consistency of thought
- the minimal number of fixations on a line of text
- constant forward movement of the eyes
- regular and rhythmic grasping of a group, rather than a single isolated piece of text
- quickly and rhythmically returning from the end of a line to the beginning of the next line
- the visual range is expanded with an objective to perceive a greater amount of information

The ability to read musical notation enhances musicians' skills and is considered as a great contribution to mental training. Miranda (2022) asserts that note reading improves memory and concentration and develops attention to details. Students who read notes while reproducing what they see develop brain flexibility and the ability to multitask. The skill of pattern recognition, which involves understanding the logical and rhythmic connection between them, has also demonstrated a favourable effect on spatial imagination (Miranda, 2022).

The development of competence in reading musical text like an acquisition of a new language, requires regular practice and consistent effort. Therefore, it is crucial for piano teachers to employ effective and often individualized approaches to their students. The idea is to establish a logical chain that supports the learning of a new skill and fosters engagement with the rich and varied world of sound and music (Hallam, 2006).

A variety of techniques were identified for the learning of musical notation. Among these methods is one that focuses on C as the starting point with the subsequent notes learned after that. Another approach involves learning the notes of the treble clef and then progressing to the bass clef (Jacobson, 2006, p. 35). Alternatively, there are pedagogical approaches that employ phrases to teach notes located on the lines and spaces. For example, Every Good Bird Does Fly and FACE for the treble clef and Great Big Dogs Fight Animals and All Cars Eat Gas for the bass clef. Regardless of the pedagogical strategy employed by the teacher, whether it be a combination of methods or an original methodology, it is crucial to cultivate reading skills fluency. As Craige (1993, p. 27) contends, musical literacy should be taught rather than grammar. However, some educators, with well-intentioned goals of simplifying note reading for students, mark the note names in the text. Furthermore, students are then expected to mark all the notes themselves as a home task before they actually start playing the piece. A more in-depth examination of this issue reveals that educators are in fact causing harm to their students by hindering the process of fluent note reading.

As Craige (1993, p. 28) emphasizes, reading a text competently and effectively requires an approach that considers whole words and phrases rather than individual letters. By their very

nature, the individually written letters beneath the notes do not form recognizable words, and as a result, the student's gaze is forced to rest on a single letter, analyzing its location on the instrument. This type of music reading can be considered as a bad habit.

The student's attention is unable to grasp the broader context, melody direction and other nuances of the musical text, and consequently restricting the development of the reading skills. Craige (1993, p. 29) draws a parallel between reading a book text and a musical text and emphasizes that in music there is vertical and horizontal reading. Consequently, reading in patterns and phrases, covering more textual details, is a more effective approach than a note-by-note reading.

In the context of piano lessons, students who encounter difficulties with reading musical notation may require a greater amount of time to master the pieces. Hardy (1998) argues that, in most cases, there are consequences, and students drop out of piano lessons because of problems in reading musical text. This phenomenon can be viewed as a predictable scenario, as it is characterized by a decrease in interest, leading to a lack of enjoyment in playing and learning new pieces.

To compensate for and prevent such a deficiency, the author introduces interactive tools for memorizing musical notation and developing fluent reading skills in Implementation chapter.

## 2.4 The Development of Technique and Quality of Sound

The concepts of technique and musical sound quality are firmly linked and their consideration as separate factors is impractical in the context of piano pedagogy. Neuhaus (1987, p. 77) established a solid foundation by stating the idea that "Technique cannot be created from nothing, just as form cannot be created without any content." This statement emphasizes the importance of musical expression first, followed by technical development. Therefore, the sound quality and content of the composition determine which methods and technical solutions the pianist will choose for the performance.

From a physical point of view, pressing a piano key sends an impulse that is transmitted to the instrument. This makes the hammer to strike the string, causing it to vibrate and produce sound.

Its quality depends on the pressure applied to the key and the energy expended in playing. In this context Neuhaus (1983, p.57) states, that the art of piano playing encompasses a wide range of sound gradations, from loud to soft, from gentle to majestic, from light to deep, and much more. The interpretation of a piece always dictates the methods of sound production. Consequently, a pianist's technical repertoire involves not only the ability to perform specific physical movements but also the capacity to shape each sound in a musically meaningful way. According to Thompson (2018), pianists employ a combination of emotional, spiritual, intellectual, intuitive, and physical energy in playing to achieve the desired result. Neuhaus (1983, pp. 77-80) further asserts that, due to the mechanical nature of the piano, the pianist must coordinate the entire body with the instrument's mechanics, relying on natural anatomical and motor skills. This incorporates the movement of the fingers, hands, forearms, shoulders, back, and even the legs. In this context, piano technique is determined as the work of the entire body, combining the understanding of when and how to apply its resources correctly and the understanding reasons for doing so.

The formation of the physical apparatus and technical arsenal of the pianist is accompanied by the coordination of his movements. Petrenko (2015) refers to coordination of movements as skills closely related to the development of thinking, hearing, and rhythm. Due to coordination during the performance, the independence of each element of musical texture and at the same time the harmonious connection of individual musical lines is preserved. Petrenko (2015, para. 2) asserts that the harmonious coordination of elements within the musical texture serves as a fundamental principle for ensuring performing freedom. In her work, Karpenko (2017) defines coherent coordination as a process that generates a specific sound, speed, and accuracy. She emphasises that economical hand movements are essential for successful technical training of students. The principle of economy should be integrated into all physical actions of a pianist. This approach facilitates the achievement of optimal sound quality and simplicity, purposeful, and efficient piano playing (Karpenko, 2017, paras. 9–11).

## 2.5 Pedagogical Approaches and Creative Teaching

The specificity of musical art determines the principles of music education, regardless of specialisation. According to Barysheva (2021, p. 20), pedagogy has general rules that increase the effectiveness of the learning process, one of which is the principle of accessibility. This approach states that the material should be understandable to the student and correspond to their level of

development, age and capabilities. The principle of purposefulness dictates that work on each piece should be aimed at achieving a specific goal, while the principle of visualization is also important. Barysheva (2021, p. 21) asserts, that in music, it is imperative to comprehend the content of the piece and its character. To this extent, the visual or illustrative method can be employed to draw student's attention to such details as the title or signed notations in musical text. The student develops a variety of skills and abilities during the learning process. In addition to fostering emotional and technical competencies, educators nurture students as individuals, encouraging the development of their own perspectives and cultivating their capacity for responsibility in decision-making.

In the domain of piano training, the very structure of individual one-to-one lessons suggests a personalised approach. This approach affords both the student and the teacher considerable freedom and creativity. Within the pedagogical context, with student-centred focus, the utilisation of creative teaching methods is an essential component and should be cultivated. Zhao (2022, p. 33) argues that the early twenty-first century has seen increased interest in creative flexibility and innovative pedagogical methods in the education system. The author also argues that creativity promotes students' personal development. However, this new approach also requires teachers to develop skills in improvisational pedagogy and adopts a reflective approach to teaching. Practice shows that when teachers create a positive learning environment, both teachers and students are able to actively participate and take risks. Moreover, it becomes evident that such practices lead to high levels of engagement for both teachers and students.

In contrast, in the master-apprentice teaching model, teachers are in a stronger position due to their access to a variety of materials and resources. This allows them to choose the most appropriate teaching method for each student. Teachers are guided by the individual needs of the students, their abilities and potential, while following the curriculum. The master-teacher significantly influences the students' professional growth, guiding them through the learning process by demonstrations, suggestions, comparisons, and feedback (Jørgensen, 2000, p. 7). Although the student remains in a role of recipient and has limited space for individuality and creativity, this is nevertheless highly desired and appreciated.

The relationship between educator and student has been shown to have a significant influence on the development of the student's skills. Lehmann et al. (2007, p. 187) indicate, that the mentor-friend model of teaching has been found to be particularly beneficial to the student's development. This model fosters enhanced communication between teacher and student, thereby unlocking the student's potential, encouraging autonomy, and promoting motivation to learn. Additionally, it has been observed to generate independence and creativity.

Zhao (2022, p. 44) asserts that when students feel supported, they are able to express and formulate their ideas freely. This encouragement of students' creative thinking and the posing of open-ended questions has been shown to develop students' critical thinking skills and to allow them to be open minded to new ideas and creativity. Moreover, when educators prioritize students' individual needs and personalized educational goals, it leads to a shift from traditional rote learning to dynamic, student-centred approach. This shift promotes diversity in the learning environment, allowing students to turn from passive observers to active explorers. In this case, it is not simply a transfer of information from teacher to student, but the students themselves change, gaining knowledge from their own experience. In this teaching model students gain self-confidence through learning and increase their self-esteem (Zhao, 2022, p. 44). Gaunt et al. (2012, p. 28), in turn, suggest that educators should take a holistic approach to the student's personality, considering both long- and short-term aspects of development, rather than being satisfied with a narrow focus on passing specific professional competencies.

Similarly, Zhao (2022, p. 46) points that an effective pedagogical approach to instrumental learning involves a combination of teaching methods, including individual and group lessons as well as regular masterclasses. In such a context, students demonstrate increased initiative and responsibility. In conclusion, Zhao (2022, pp. 48–55) argues that creativity should be demonstrated at every opportunity. The extent to which students develop creativity depends on the support provided by the teacher. Effective classroom management, the incorporation of imagination in musical performance, the establishment of connections between musical analysis and performance, and the discussion and formulation of conclusions are all crucial factors in fostering creativity. Zhao (2022, p. 49) emphasises the significance of encouraging musical expression and technical skills in instrumental classes to inspire student’s musical performance.

This cumulative approach is undoubtedly an action that helps students think critically, gives confidence, and develops independence.

In light of the above, technological innovations have a place in developing students' creative potential on an individual level, fostering their independence and confidence in daily classes, in the analysis and practice of musical compositions, as well as in preparation for performances and concerts.

## 2.6 Emotional and Aesthetic Aspects of Music Education

In piano pedagogy, the beginner, especially the young child, must be helped to enter the complex world of music. The teacher is assisted by associative thinking and its emotional expression. This type of thinking is actively involved in the process of absorbing information. Memorization and comprehension process are based on the student's previous experience. In other words, if the presentation of new knowledge includes familiar elements that are directly or associatively linked to material that the student knows and understands well, this knowledge is assimilated naturally and successfully (Trefilova, 2022).

Ryazanova (2020) asserts that associative thinking enables students to participate directly in the process of discovering new facets of education and understanding the essence of music in relation to other forms of art. It reveals the transformative power of music and its influence on the inner world of student, the attitude to the surrounding reality, the formation of own opinion and ability to listen, hear, and comprehend what is heard as a living matter.

The development of students' associative, figurative, creative, imaginational, and critical thinking skills is facilitated by integrating music with other artistic disciplines, including literature, fine arts, cinema and theatre. This integration enables students to master the language of music by identifying its similarities and differences across various artistic forms. The integrated teaching system is characterised by the intensive use of interdisciplinary links (Ryazanova, 2020).

By the emotional aspect, Qi et al. (2017, p. 3) refers to emotional expression and mental communication. In addition to mastering the correct playing and reading of music, the role of the teacher is to nurture students' imagination, emotions, comprehension of the musical piece, and

the capacity to evoke an authentic musical image. The integration of emotional and aesthetic aspects in piano education cultivates students' personal qualities. Through the implementation of emotional playing, students identify and develop their creative capacities. Furthermore, through performance, they transmit their emotions to the audience, thereby evoking emotional resonance in return (Qi et al., 2017, pp. 5–6).

From another perspective, Pecherskaya (2020) identifies the intellectual and emotional spheres of the student as the foundation for comprehending musical imagery and engaging in creative interpretation. These aspects are cultivated during lessons and are a primary focus for educators. Specifically, Pecherskaya's (2020, para. 3) conceptualisation of the development of musical analytical thinking is outlined as follows:

1. Historical Context. The study of the style norms of the historical background in which the composer lived and made the given work.
2. Musical content. The element of analysis involves the study of intonation material as a guide in the logical construction of the work. It also includes comprehension of form, means of expression, texture, rhythm, the ability to find similarities and differences, to analyse and find connections.
3. The development of the student's imaginative and emotional potential. Depending on the age of the student, the teacher offers associative-artistic images based on literature, poetry, fine arts and history.

This approach has been demonstrated to facilitate the development of students' artistic and imaginative thinking, as well as their musical consciousness. Furthermore, it has been shown to contribute to the expansion and deepening of students' emotional range, the diversity of sound colours, and the content of music. This, in turn, has been found to stimulate the complex development of students and to enhance their motivation for lessons.

In this pedagogical context, the integration of additional technological resources, particularly the use of Internet-based platforms to access enriched visual, auditory, and intellectual materials serves as a valuable educational tool, supporting students in developing a comprehensive understanding of a musical work or even an entire historical period.

## 2.7 The Judicious Selection of Repertoire

The nature of piano lessons involves an individualised approach to the student, enabling the teacher to adapt the pace and methods of teaching according to the student's capabilities and interests, with the aim of optimising their potential. A sensible selection of repertoire familiarises

the student with a numerous example of global music while developing their piano playing skills. This selection is based on an analysis of the student's abilities, providing the foundation for choosing pieces that contribute to their optimal technical and musical development (Barysheva, 2021, p. 83).

It is necessary that the repertoire corresponds to the level of the student, arouses interest and desire to practice. A competent teacher pays special attention to repertoire, because it develops the student's thinking, independence, and encourages them to explore creative endeavours. When choosing repertoire, it is necessary to take into account not only pianistic and musical tasks, but also the student's intellect, artistry, temperament, mental qualities, and tendencies (Barysheva, 2021, p. 84).

A wise selection of repertoire fosters a trusting relationship between teacher and student, which in turn is crucial in the educational process. This relationship fosters student involvement in the repertoire selection process. It is the teacher's responsibility to ensure a comprehensive introduction to music from various historical periods and stylistic traditions. In this endeavour, the selection of compositions must align with established pedagogical goals and objectives, ensuring a harmonious integration of musical instruction and artistic development (Barysheva, 2021, p. 84).

Barysheva (2021, p. 85) identifies three principal tasks in the selection of repertoire that a teacher faces. These tasks are as follows:

- the cultivation of creative understanding of music
- the cultivation of the student's piano skills
- the accumulation of repertoire

It is evident, that not all of the compositions studied in class need to be presented to the public. Some pieces are useful for familiarising students with a particular technique. Teacher usually determines the direction of the work with students, aiming to develop their skills and familiarise them with various piano techniques, styles, forms, textures and musical literature in general.

In particular, Barysheva (2021, p. 86) emphasises the following principles that teachers should take into consideration when selecting compositions for students:

- individual musical abilities of the student
- psychological features, namely, logical thinking, reaction, and temperament
- age-appropriate characteristics of the child
- works that are selected with consideration for the formation of artistic and intellectual taste and the development of performing technique
- artistic diversity
- systematic and gradual complexity
- repertoire in accordance with the curriculum

In turn, Magrat (2017) argues that the choice of repertoire depends on a careful balance and combination of what the student wants to play and what the teacher believes the student needs to play at that moment, as well as on the harmonious correspondence of the new piece with the student's current repertoire so that it concisely echoes the other pieces.

Consequently, the selection of a repertoire intelligently tailored to the individual needs of each student is a key factor in a pianist's professional development. According to the author, for young or inexperienced teachers, the process of selecting repertoire often presents significant challenges, since understanding the pedagogical significance of each piece requires practical experience. Based on the author’s teaching experience, often, potential technical or artistic difficulties for a student are only revealed during the course of learning the musical material. In this context, modern technologies based on artificial intelligence can contribute to a more critical and informed approach to repertoire selection, serving as an effective support tool for novice teachers.

## 2.8 The Application of Contemporary Educational Technologies in Piano Teaching and Performance

Practice has demonstrated that in the contemporary educational environment, characterised by the accelerating pace of life and the overflow of diverse information, students often encounter challenges in engaging with extensive and detailed musical texts. It can lead to a decrease in their motivation for lessons. However, updating the attitude towards education and its reorientation requires teachers to get familiar with innovative pedagogical technologies and master interactive

forms and methods of teaching. Both teachers and students are opening new doors to the opportunity to develop skills and abilities for creative self-realization, positive and interactive learning within the context of modern socio-culture (Trefilova, 2022).

Therefore, this interaction of human and technical resources is strategically designed to achieve a more effective form of education. The application of technology in the teacher's activity is associated with a sequence of certain actions and is aimed at achieving the set goals. One of the main objectives of the application of technology in teaching is to improve and enrich the pedagogical skills of the teacher.

The present study has been designed to provide a comprehensive analysis of the potential of innovative technologies with a particular focus on their application in piano pedagogy. It will also offer examples and recommendations for teachers and students.

# 3 Research Layout

The motivation behind this research and subsequent study was driven by two factors. The first is the need to respond to evolving conditions within contemporary educational environments, particularly in the context of piano pedagogy. The second factor follows up from the author’s twenty-seven years of continuous teaching experience and interaction with school-age students in creative learning environments. This experience has revealed that students often respond positively to innovations and new pedagogical approaches. These observations suggest that creative learning environments naturally align with children's curiosity. Such interactions foster interest, motivation, and active participation in the learning process. This study aims to serve as a valuable resource for fellow piano educators and their students interested in contemporary teaching approaches.

The study consists of six main chapters. The introduction describes the key characteristics of contemporary piano teaching with focus to the new learning environment, an integrated approach to piano pedagogy, and the role of the teacher as an educator. In Chapter Two, the reader is introduced to the fundamental, methodological, and pedagogical components of piano education. These include the cultivation of sound quality, consistency, and progress in the student's development as a pianist. The chapter also encompasses the overcoming of technical difficulties

and the development of numerous skills and factors that influence the growth of the musician as an individual. Chapter Three addresses the research task and problem, chosen strategies, methods of data collection and analysis, and a framework of reliability and ethical principles. In the Fourth Chapter the author provides a comprehensive overview of contemporary technological tools designed to diversify, enrich and enhance piano teaching. These tools make piano learning more engaging, accessible to new discoveries and possibilities, and beneficial to the development of students' autonomy, self-esteem and individuality. In parallel, the author is testing all the innovations in practice with piano students. In the Fifth Chapter the reader is familiarized with the main outcomes of the research, interview results, and practical testing. In the sixth final chapter, the reader will find conclusions and potentially new opportunities for further research.

## 3.1 Research Task and Problem

A desire for continuous improvement is a fundamental component of any research project. Research involves exploring potential solutions to emerging questions or problems. The purpose of research is to contribute to a specific field of study and to broaden and deepen existing knowledge. As research progresses, new findings help answer previously raised questions, gradually building a more comprehensive understanding of the subject.

Creswell (2012) articulates it in such a way that the problem, task, and research question encompass the phenomenon under investigation in a principle from broad to specifically narrow. Therefore, the research topic is the broad subject matter addressed in the study. The problem that is examined in the study directs the search to a specific subject which forms the research objective. The objective is thus narrowed down to posing a question that will be answered by the author as a result of the research (Creswell 2012, p. 60).

The goal of the author of this study and the primary task is to analyze and develop methods and approaches that allow the effective use of modern technologies in piano teaching, as well as to improve the process of music education in the context of changes in the educational environment and the demands of contemporary students.

The author formulates the research problem as the adaptation of traditional classical piano pedagogy to the requirements of the time, including the use of new technologies to improve the

quality of teaching. The author of this study believes that integrating modern digital technologies such as music applications, online educational programs, and interactive platforms into the piano learning process will increase students' motivation and engagement as well as improve their musical skills.

The result of the study is a recommended model of approaches to teaching, combining traditional methods of teaching piano and the use of modern technologies, methodological recommendations and justification of the effectiveness of technology integration into the educational process.

The study concludes with an analysis of its central research question, namely:

- how the integration of modern technology into twenty-first century piano pedagogy can be effectively implemented to enhance teaching quality
- how it can boost student motivation
- how it can adapt teaching methods to the evolving demands of the educational environment

## 3.2 Research Strategy

As previously stated, the fundamental purpose of any research is to contribute to the advancement and enhancement of education. To answer the research question, the author used a qualitative approach, based on case studies and supported by collected empirical data. Creswell (2012, pp. 2–3) describes research as a systematic process that involves the collection and analysis of data in order to develop a deeper understanding of a specific issue. Choosing the right research strategy in this case directly affects the achievement of reliable results. However, it is essential to maintain focus on the research goal. According to Patton (2015, p. 199), all research methods have their strengths and weaknesses, relying on a single method is insufficient. For this reason, Patton (2015, p. 208) suggests using combined research methods and emphasizes the value of multiple qualitative source methods in research and evaluation. This approach is particularly relevant in educational research, where critical reflection on methodological decisions is essential to reduce bias and improve the effectiveness of analysis.

For example, qualitative research focuses on an in-depth study of a topic in all its details (Patton, 2015, p. 87). According to Creswell (2012, p. 16), this approach is especially relevant when variables are not clearly defined, and the existing literature does not fully reflect the phenomenon being studied. In such situations, data collected directly from participants allows for a more complete and detailed understanding of the topic.

On the other hand, Bhandari (2020) notes that qualitative research is particularly appropriate for studying phenomena or experiences involving non-numerical data. In educational research, this approach is widely used both for data collection and for developing new concepts and interpretations.

When research involves describing, comparing, evaluating, or gaining a deeper understanding of a specific phenomenon, it is better to use a case study approach (McCombs, 2023). This approach focuses on a detailed examination of a specific topic or context and is often used alongside qualitative methods, particularly in educational research. McCombs (2023) describes case study analysis as a focused and in-depth method of examining the key characteristics of a phenomenon and its broader consequences.

The present study examines an educational phenomenon that has not yet been sufficiently researched. It explores how modern digital technologies can be used in teaching classical piano. Their application opens up new opportunities for a variety of teaching methods and makes the process more flexible. The primary goal of the study is to describe, compare, and evaluate how these technologies can be implemented in educational practice.

## 3.3 Data Collection

According to Anttila (2014, Section 4.1.1), using multiple data collection methods and sources can increase the reliability and credibility of research results. In qualitative research, a combination of methods such as interviews, observation, researcher notes, and analysis of original documents allows for the study of a phenomenon from multiple perspectives (Antilla, 2014, Section 7.3.1). Bhandari (2025) also notes that qualitative research often relies on both primary and secondary data sources for a more complete understanding of the research subject. Using multiple methods

also allows to compare the results obtained from different data sources, which increases the overall reliability of the study.

McCombes (2023) emphasizes that the purpose of data collection is to achieve the most complete understanding of the phenomenon under study and its context. In case studies, this is typically achieved through qualitative methods such as interviews, observations, and analysis of primary and secondary data sources. In turn, Yin (2018, p. 153) notes that the presence of similar findings across multiple sources serves as evidence of credible information. In addition, data collection can be carried out over short or long-term periods, which significantly affects the depth and quality of the collected data.

Considering the above factors, the author adopted a dual approach to data collection, which included both primary and secondary data collection methods. Primary data were obtained through a semi-structured expert interview and through the practical application and testing of contemporary digital technologies in piano teaching.

In order to collect objective data on the role of integrating modern technologies into piano pedagogy and to identify the most effective methods, a comprehensive approach was necessary. Therefore, the subsequent step in this direction, as taken by the author of the study, was to apply the analysis of educational programs, platforms, games, and digital applications with subsequent testing. For this purpose, a group of 32 school-age students (from 7 to 18 years old) studying piano was selected. During the 2024-2025 academic year allocated for testing, students received assignments and applied technical innovations in their practical work. All the students were piano students of the author. All the educational music platforms and applications mentioned in Chapters 4.1-4.4 and 4.7 were presented to the students individually, then, with the support of their parents, a choice was made which applications or websites the students would use for independent home practice. Some students used technical tools in their daily practice, while others used them 2-3 times a week. For this reason, the author kept notes and maintained contact with parents. The primary focus was on reading music notation, understanding rhythm, musical symbols, and theoretical knowledge.

Anttila (2014, Section 9.1.4.6) confirms that in order to collect special or specific data, particularly within a technical field, it is more advantageous to conduct interviews with experts. Such a pre-selected interview candidate should represent the organization, be well educated and an expert in the field. Consequently, a technological expert was selected as the interviewee for this study based on clearly defined professional criteria. The interviewee specializes in information technology related to musical instruments and has more than ten years of experience working in this field. This export is recognized as a leading specialist in Finland in the area of hybrid and digital piano technologies. An interviewee's professional background provides in-depth knowledge of the technical structure, digital systems, and functional capabilities of instruments such as the Disklavier and other hybrid models. This technical expertise made him a suitable expert for examining the technological potential of these instruments within a pedagogical context.

The interview data were analyzed using thematic coding. Responses were organized into key themes directly related to the research question, with a particular emphasis on the technical capabilities of hybrid instruments in a pedagogical context. The analysis focused primarily on how these technological features can support teaching and learning processes. Although the interviewee represents an official distributor of Yamaha instruments, the discussion was focused specifically on the technical features of hybrid and digital pianos in the context of piano pedagogy. The questions were designed to explore how these technical capabilities may support teaching and learning processes rather than to promote particular products. Therefore, the analysis concentrates on the pedagogical relevance of the instruments' technological functions.

As the organization represented by the expert positions itself with those seeking cultural enrichment through music and excellence in the arts and has strong relationships with leading educators and renowned institutions in Finland, the information provided by the interview can be considered as a reliable source. The author is confident that the opinion of the expert in a field provides a solid foundation on which further study can be built.

Due to the fact that a thorough preparatory analysis was carried out before conducting the interview with the expert, the author of the study decided to use the method of focused and semi-structured interviews. Anttila (2014, Section 9.1.4.2) characterizes these methods as optimal for revealing a particular task or object under study. The author chose these types of interviews in

order to talk in a well-planned yet free atmosphere so that the interviewee had some freedom to answer open-ended questions. To ensure the quality of the responses, the expert was provided with the questions in advance, encouraging thoughtful consideration rather than spontaneous answers.

## 3.4 Data Analysis

Classical piano art has rich history and is taking a new turn in the field of technology application. The principles of classical pedagogy and methodology are not only being equipped but also enriched through the use and implementation of modern technologies. In this context, the analysis of the collected data was conducted as part of a qualitative thematic study and was based on relevant theoretical approaches in the field of piano pedagogy and educational technologies. The purpose of the analysis was to examine how modern digital innovations are reflected in classical piano pedagogy and how they contribute to improving teaching and learning practices.

In the context of case study research, Creswell (2012, p. 212) considers data analysis as the identification of repeated patterns, concepts and ideas in order to form groups that will give answers to the main research question. Creswell also suggests starting with theoretical propositions and developing a logical chain connecting different sources of data. Accordingly, the analysis in this study was based on a theoretical foundation drawn from pedagogical and methodological literature and supported by empirical data.

Patton (2015, pp. 1033–1034) explains that qualitative data analysis transforms raw data into meaningful findings through interpretation. Despite the fact that qualitative analysis involves a large amount of information and complex data, organizing it into a system supports the analysis. Such methods as filtering secondary information, identifying key points, and tracking repeated patterns allow researchers to organize data into a holistic analytical structure.

In light of the above and in line with Antila's (2014, Section 8.2.2.5) recommendations for qualitative and case study analysis, the data analysis was conducted in the following steps:

- The information obtained from the methodological and pedagogical literature that formed the theoretical basis was thoroughly studied. Parallels and comparisons were made, revealing the

essence and main points of classical piano pedagogy, as well as the possibilities and areas for the use of the latest technologies.

- The interview with the expert was conducted in video format and transcribed word for word. In addition to verbal content, relevant nonverbal cues such as gestures, facial expressions, and intonation were taken into account if they contributed to the interpretation of responses. The answers were categorized, repetitive patterns were identified, filtered, and critically analyzed in relation to the research objectives. Afterwards, conclusions were drawn.
- The practical testing of educational programs, platforms, and digital applications was analyzed to identify general trends related to their effectiveness, accessibility, and pedagogical value. The observations and outcomes of the testing process were documented in written form for further comparison.
- Finally, theoretical insights and empirical findings were integrated and compared across data sources. This cross-analysis identified converging themes and supported the formulation of conclusions regarding the role of modern technologies in classical piano pedagogy.

## 3.5 Reliability and Ethics

Patton (2015, p. 984) emphasizes that qualitative research methods, particularly interviews, can be counted as reliable in terms of obtaining information from a primary source. However, interviews involve direct interaction with individuals. It is the responsibility of the researcher to ensure confidentiality and handle all data with care throughout the research process.

Anttila (2014, Section 11.1) also emphasizes the importance of confidentiality in research work. Responsibility and careful consideration of data protection and ethical issues must be taken into account at all stages of the research process. Accordingly, when collecting, processing, storing, and analyzing data, the author considered the principles of reliability, credibility, and validity. In particular, all interview materials, including video recordings and transcripts, were stored securely and were accessible only to the author during the research period. These materials were permanently destroyed immediately after the publication of the study.

The identity of the interview participant and the students involved in the testing was kept strictly confidential. In all documents, participants were identified only by numbers. This coding system was known only to the author and helped prevent any possible identification of the participants. Therefore, the research was conducted responsibly and in accordance with the standards of Finnish universities of applied sciences.

Anttila (2014, Section 11.1) continues the discussion of ethical principles in research, recommending researchers to determine, evaluate, and anticipate potential risks associated with different research methods. Furthermore, the right of individuals to receive accurate and sufficient information about the nature of the research, its procedures and purpose is emphasized. The author's actions were, therefore, characterized by thoughtfulness and care. Participants in the study were informed about the study, its purpose, and confidentiality, and consent to participate in the study was subsequently obtained. Participation in interviews and application testing was anonymous and voluntary.

Particular attention was given to the responsible handling of data, including the collection, secure storage, and disposal of materials after the completion of the study. Ethical principles have also been taken into account and applied when using citations and references. The selection of literature was conducted critically and accurately. Such measures supported both the reliability and ethical integrity of the study, as well as the validity of the achieved outcomes.

# 4 Implementation of Technology in Piano Teaching

The development of digital technologies in recent years has dramatically changed the methods of teaching and learning. As a result, educators have begun to adjust their methods and explore new ways of teaching. In music education, the use of online tools such as educational platforms, music theory games, and recorded materials has supported teaching by increasing access to learning resources and online instructions. Consequently, these new technologies have motivated educators to explore and adopt contemporary methods, thereby contributing to their professional development.

Filaretova (2019) is convinced that the use of innovative methods in piano teaching has a beneficial effect on students, contributing to the formation of an aesthetic, emotionally integral attitude to music, and the realization of students' creative potential.

Technical innovations in piano pedagogy can be considered from the point of view of different categories, depending on their function, technological approach, hardware, and application. Innovations are also considered in terms of degree of difficulty, ranging from beginner to advanced levels. It should be noted that only those innovations that serve to support the piano

pedagogue are taken into consideration and investigation. Moreover, all information presented in this chapter has been empirically evaluated through the author's own pedagogical experience and practical implementation with her students. From the author's perspective as a piano educator, the applications and findings are considered useful and serve as an excellent supplement and support for the development of students and the expansion of their musical horizons.

## 4.1 Free Educational Music Learning Websites

### Dr. Music

One of the first websites to gain popularity and attraction among music educators, including those in Finland, is Dr. Musik. This website was created by Canadian music educator Thierry Simard. It is free to use and is compatible with computers, iPads, and mobile devices. The friendly website offers a creative, interactive and exciting journey into the world of music. Dr. Musik opens up opportunities for younger students to practise rhythmic patterns, compose their first musical pieces and develop absolute pitch. Dr. Musik comprises a variety of games, thereby allowing students to choose different formats through which they practise and develop their music skills.


Figure 1. *Dr. Musik Website Interface*

*Note.* Screenshot by the author.

Young adventurers will find themselves either in an underwater world, on a treasure hunt or robotics construction. The auditory component of the games is characterised by the accompaniment of rhythmic music in the style of the chosen format. When student selects a correct pitch, the pitch sound is heard, and student gets the particular auditory experience developing the hearing absolute pitch skills. It is posited that students, including both boys and girls have the opportunity to choose a theme that aligns more closely with their individual interests. Of particular interest is the recognition of the instrument by ear, which in turn develops the pianists' sound imagination and helps them to achieve different timbres and sound qualities in their playing.

Furthermore, the creators of website incorporated a feature that enabled users to provide feedback on the games, including suggestions for enhancement and development. It is evident that young talents are presented with the opportunity to provide feedback and exert influence over the creation or adjustment of the game.

## Musicca

Another website, Musicca, was identified as a favourite among educators and students. This free, popular music platform all over the world was created in Denmark in 2019 by Lasse Grubbe. The software is compatible with any device, and the creators' mission is to ensure that music education is highly qualified and accessible to all. The music platform is available in twenty languages and is subject to constant updates, with new languages and features being added on a regular basis.

It is noteworthy that the creators of Musicca have incorporated a feedback mechanism. It is possible to locate a contact form on the website, through which suggestions for further enhancement may be directed to the developers. At present, the website is not available in Finnish, however, since Musicca is continually adding new languages, it is expected that Finnish will be supported in the near future. Musicca is a useful resource for studying music theory, developing perfect pitch, visually and aurally identifying instruments and genres of music.

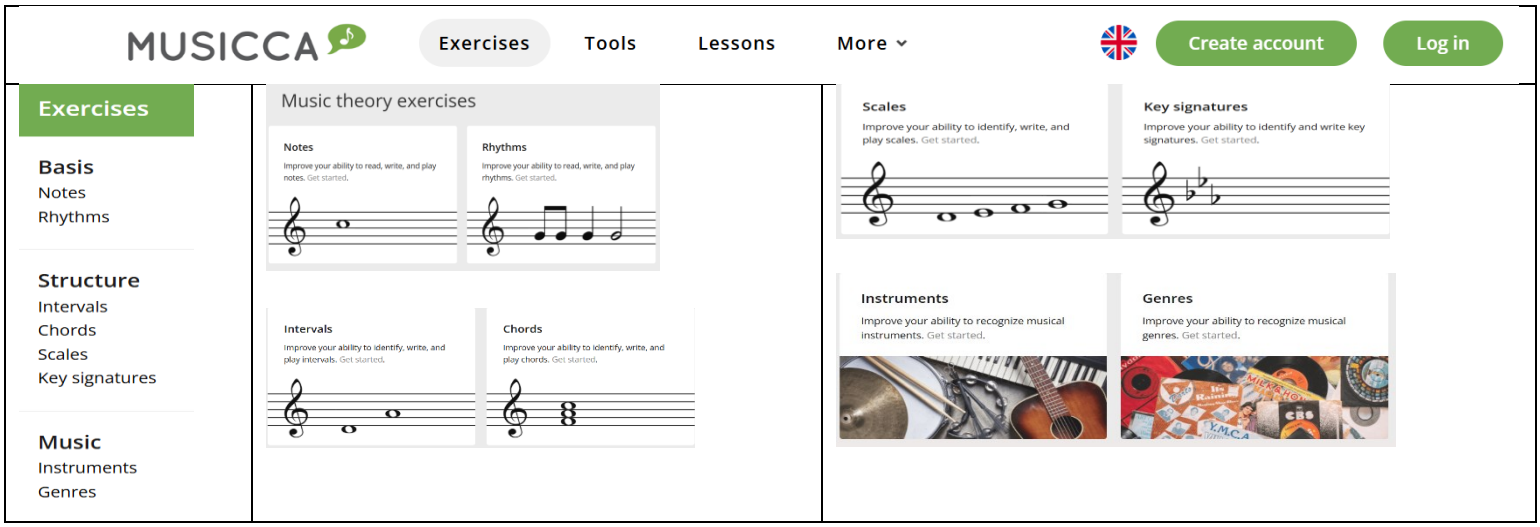


Figure 2. *Musicca Website Interface*

*Note.* Screenshot by the author. The figure illustrates the music theory classes.

The difficulty level of exercises in Musicca varies from simple to complex, allowing students to systematically and gradually reinforce the material they have covered. In addition, students with different levels of preparation will find useful and interesting tasks here and the opportunity to learn something new.

As a part of the curriculum at Finnish music colleges, the development of technical and theoretical knowledge, including scales, chords, arpeggios and free accompaniment is mandatory for all piano students at all levels. In such cases, Musicca serves as an ideal supplementary resource for students, facilitating independent learning at home. Following by comprehensive explanation of their teacher, students are empowered to independently continue their musical development at home, enhancing their musical proficiency.

The music theory exercises have been designed to develop the ability to read music notation, write music, find notes on the keyboard and identify them by ear. The approach to learning music notation in Musicca is multifaceted. The same can be said of rhythm. The exercises presented in this study offer a comprehensive range of rhythmic patterns and time signatures, which are visualised and identified through auditory perception.

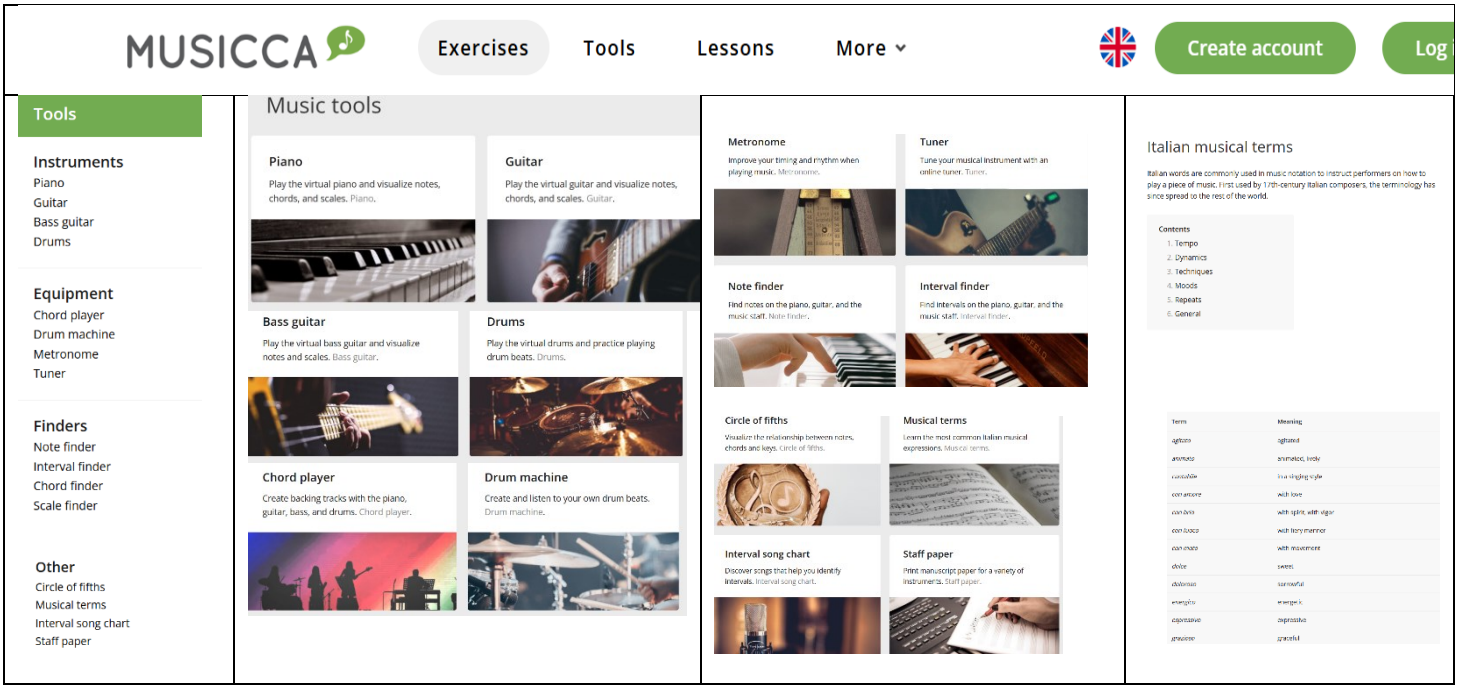


Figure 3. *Musicca Website*

*Note.* Screenshot by the author. The figure illustrates the music tools offered on the Musicca website.

Musicca is distinguished by a number of convenient functions, including the sheet music for printing, a metronome, a tuner, exercises for tenor and alto clefs, and the playback of harmonies and chord progressions. Furthermore, it is possible to generate chords and harmonies themselves, as well as their sequence, and in addition to select the style, tempo, and instruments for playback. Musicca's significant contribution is the inclusion of a comprehensive unit dedicated to musical symbols and terminology. It is evident that this feature is undoubtedly advantageous for students of all instruments.

Recently another option was added to Musicca platform that enables educators to create profiles for their students or groups of students. It makes it easy to add students, observe and track their progress, and manage their accounts.

## PianoNanny

PianoNanny is another free educational website based on Piano on the Net, which has won a decent amount of user attention and many awards since 1994. The instructor of the online lessons Clinton S. Clark is a movie composer and jazz musician, who has been awarded an Emmy.

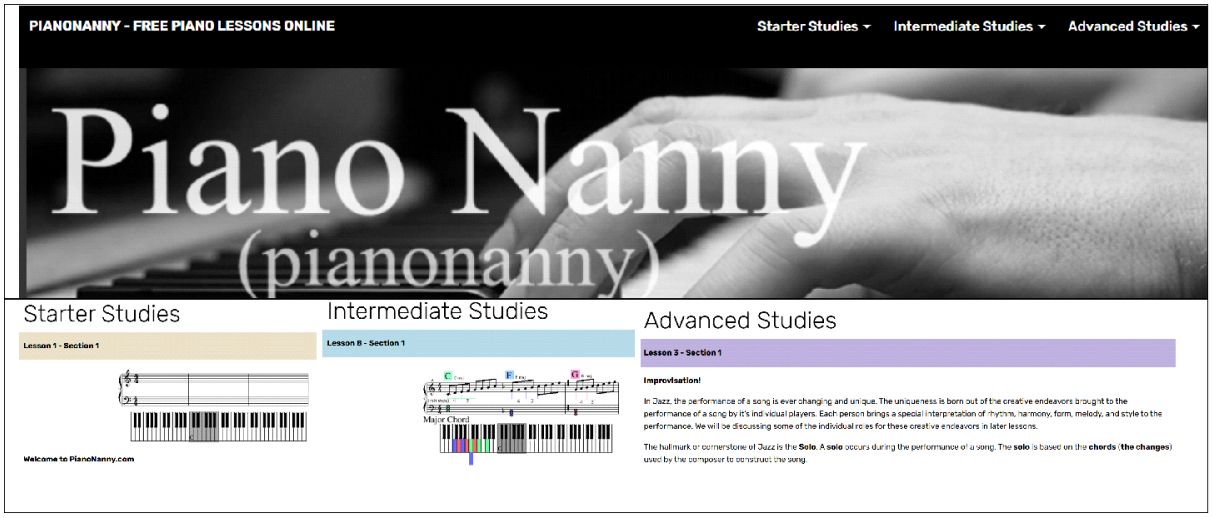


Figure 4. *PianoNanny Website Interface*

*Note.* Screenshot by the author.

The piano course consists of three levels: beginner (13 lessons), intermediate (10 lessons), and advanced (9 lessons). The lessons are organized in ascending order from simple to more complex. All lessons cover the basic theoretical background and serve as visual aids with clear and concise explanations. Along with visual examples, audio samples are also included, which serves as an excellent reinforcement of the material covered. Since course instructor Clinton S. Clark is a jazz pianist, the advanced level of the course touches on the basics of improvisation and jazz harmonies. In Finnish music colleges, improvisation is an integral component of the curriculum and is mandatory for all students. It can thus be concluded that PianoNanny has the potential to provide a supplementary information and valuable support system for classical piano educators.

## PianoLessons

For those with a passion for instructional videos and practical advice, the PianoLessons website, created by a group of Pianote experts, is an ideal resource. The selection of a themed video will

provide a student with a comprehensive response to their chosen subject of interest, whether that relates to assistance with reading and locating notes on the musical staff or to the improvement of technical dexterity. The concise lessons concentrate on fundamental concepts, serving as an effective study aid. The educational content of PianoLessons is accessible via video and short clip format on Instagram and YouTube, with regular updates also available on Facebook.

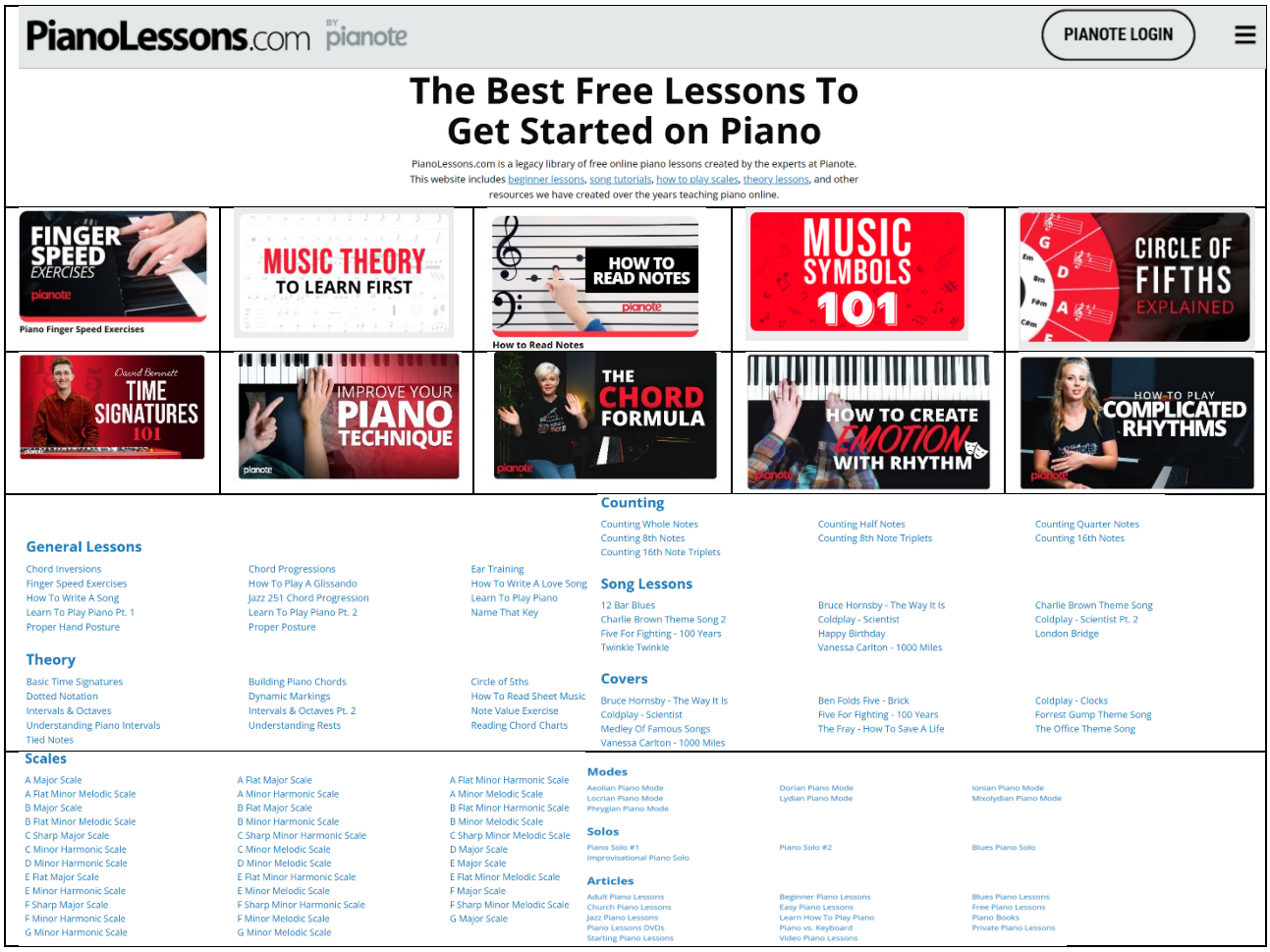


Figure 5. *PianoLessons Website Interface*

*Note.* Screenshot by the author.

## 4.2 Free Educational Music Applications

A considerable number of applications have been developed for the purpose of facilitating music literacy, theoretical understanding and the development of musical skills such as listening and rhythm perception. The majority of these resources are available for download for Windows,

MacBook, mobile, and iPod devices. Despite minor differences, the primary goal of these applications is to present the material in a fun, interactive, and active learning format. Järvi (2022, p. 17) asserts that the primary goal of game-based learning is to engage students and motivate them to achieve their goals. Using games as a pedagogical tool has proven positive potential in increasing students' engagement and interest in the learning process. Game elements such as competition or tasks of varying difficulty, as well as rewards and achievements, allow students to track their progress and enjoy the visible results.

## EarMaster

One such application is EarMaster, which has gained significant popularity. The creators of the application position it as a leading tool for ear and rhythm training, sight reading, and singing. EarMaster was developed by a group of musicians in Denmark in 1994, and the software has been constantly improved since then. The application is available for all devices, including mobile phones, computers, and tablets. EarMaster is a software application that operates on a variety of operating systems, including Windows, macOS, Android, and iOS. This characteristic ensures its accessibility to a wide audience. The free version includes several categories covering a beginner's course, voice training, solfeggio, and general musical skills development. After completing the tasks in the free version, the application offers a subscription.

In the settings menu, students can select their instrument, sound range, rhythm, and metronome. As with most similar games, students can track their progress. Game results are saved, and if a student interrupts their game, they can continue to the next level at any time. The app has a built-in microphone, which provides students with instant feedback and increases the interactivity of the application. The levels of the tasks range from simple to complex and cover the student's auditory perception, sound reproduction, fine motor skills, and cognitive functions.

EarMaster has been proved to be an effective tool for the development of ear training, solfegging and general musical skills. Real-time feedback provides immediate correction for issues regarding intonation, highlighting the necessary adjustments to achieve optimal performance. The paid version of EarMaster provides access to a more extensive range of features for both students and teachers. These include the ability to select from a variety of languages, as well as the creation or customisation of exercises for the class or for individual students. In addition, users can access an

extensive library comprising over 4,000 different assignments. EarMaster has the capacity to function in an offline mode. The numerous features of EarMaster make it an attractive, convenient and efficient software.

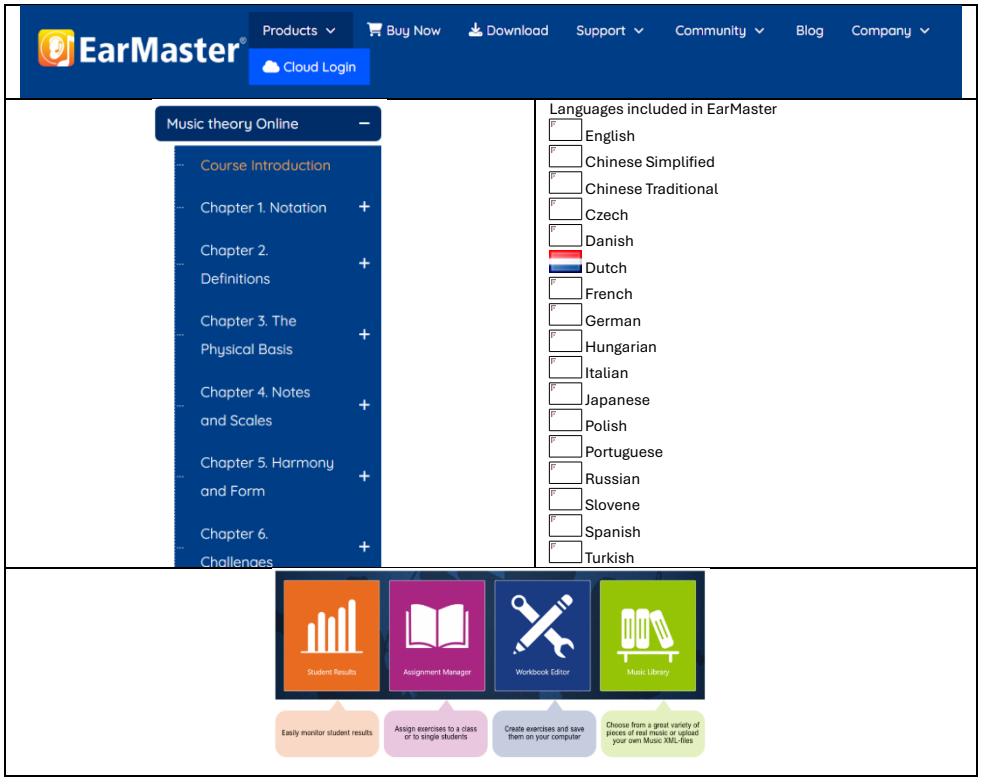


Figure 6. *EarMaster Application*

*Note*. Screenshot by the author. The figure illustrates the content of EarMaster application.

## PerfectEar

The PerfectEar application is worthy of further consideration. The PerfectEar application has been developed by Crazy Ootka Software AB and is available for iPhone, iPad and Android devices. In a format comparable to a foreign language learning application, PerfectEar enables the setting of goals and the determination of the duration of daily usage. In other words, the establishment of a tangible goal is essential for achieving the desired result. The free version of PerfectEar is quite spacious. The application is designed to provide a comprehensive foundation of theoretical concepts, accompanied by practical exercises that focus on the development of auditory and sight-reading skills. The rhythm block is designed to develop rhythm capacity and includes both

theoretical and practical exercises. Furthermore, the rhythm block facilitates the incorporation of auditory and rhythmic dictations, in addition to the creation of individual exercises.

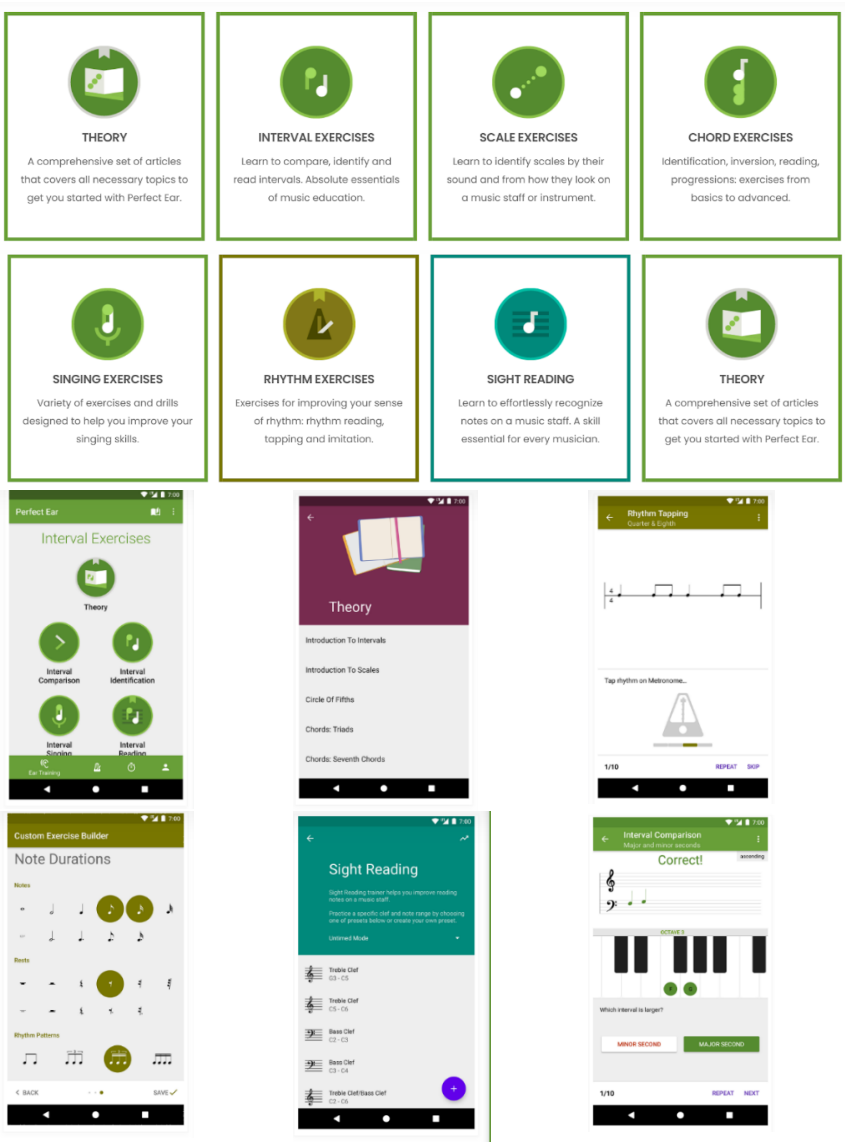


Figure 7. *PerfectEar Application*

*Note*. Screenshot by the author. The figure illustrates the content of PerfectEar application, including the available exercises.

The application has been designed in accessible language with the objective of enabling young students to engage with the exercises independently, without requiring adult assistance. In the ear training block, there are numerous exercises designed to facilitate the identification of intervals, scales and its modes, as well as chords. In the courses block, students will find three basic courses,

which are organised according to degree of difficulty. The application under review is, in general, pedagogically and methodologically sound, and is designed for gradual, smooth mastery of musical skills. It is evident, that the application is beneficial and efficient for students.

It is obvious that both the Apple store and Google Play have a wide range of applications, both paid and free, from which students and teachers alike can choose the ones that best suit their individual requirements and the tasks they want to accomplish. The following chapters will look at paid applications that are worth considering for use with students.

## 4.3 Paid Educational Music Learning Applications

This chapter examines two applications that are currently used in Finnish music colleges and are accessible to students.

### Tenuto

One of these applications is Tenuto, which is widely used in music education. It facilitates the mastery of theoretical concepts, the development of auditory perception, and the evaluation of musical knowledge. The paid Tenuto application, developed by musictheory.net, LLC and is available for use on iPhone and iPad devices. The application fee is 5.99e. The Tenuto is a highly rated and suitable for individuals aged four and above. Indeed, the extensive range of settings offers the possibility to modify parameters to suit individual students' needs, whether at the beginner or advanced level. According to the principles of modern pedagogy, this beneficially promotes an individual approach to learning. This functionality contributes to the growing popularity and high demand for this application. Within the settings, the user can select the instrument to be studied, range, playing speed, and level of difficulty. It is also possible to study with Tenuto in an offline mode, a feature which enhances the appeal of the application.

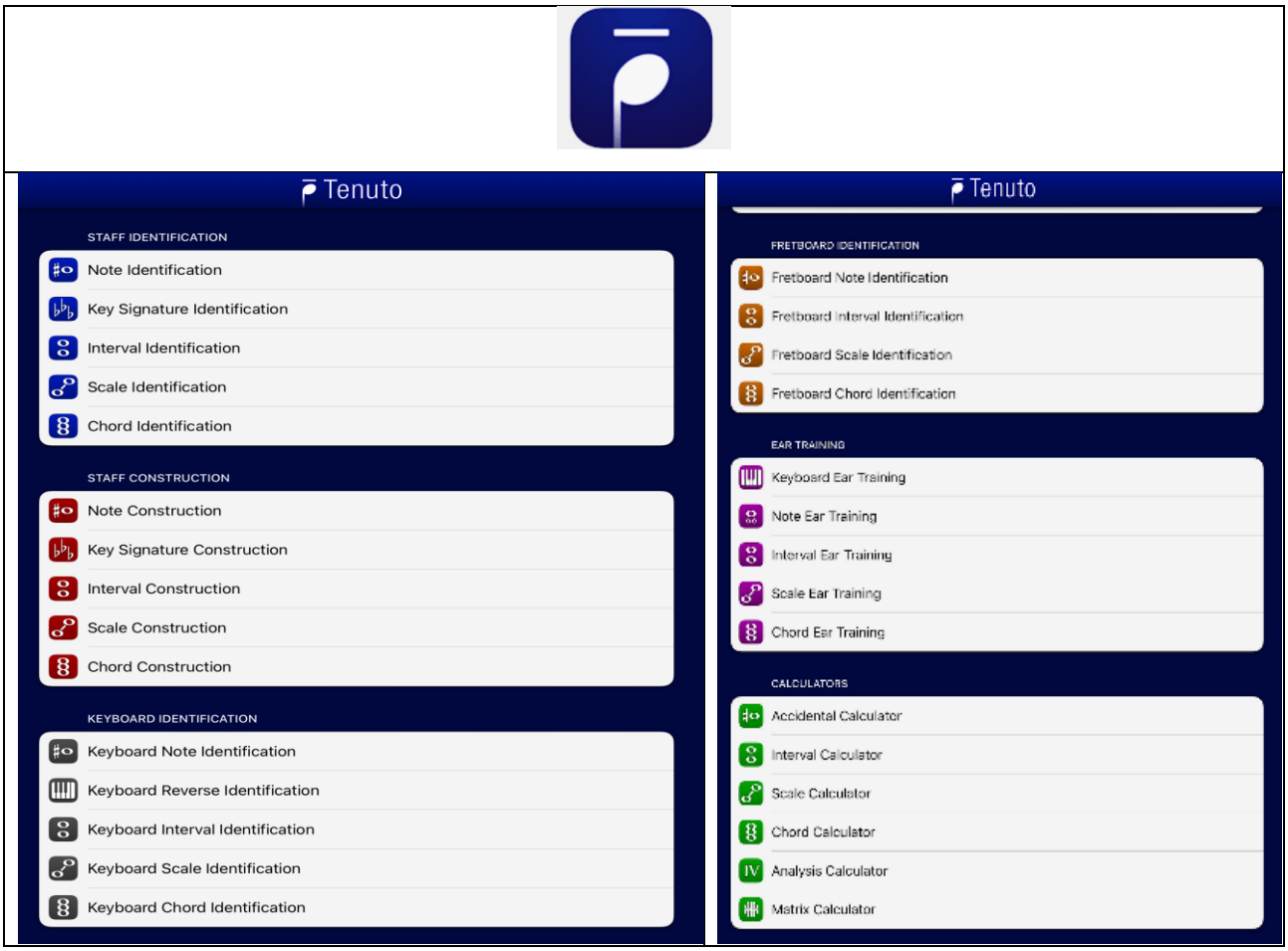


Figure 8. *Tenuto Application*

*Note*. Screenshot by the author. The figure illustrates the content of Tenuto application.

## iReal Pro

iReal Pro is another paid application that represents a noteworthy example of a functional tool available for a one-time purchase without a subscription requirement. The iReal Pro application is suitable for use on a range of devices, including Mac, iPhone, iPad, Android and Windows. It is designed to assist users in reading chord sequences. This application consists of substantial library of songs, styles and rhythms. The integrated mixer facilitates the selection of the appropriate instrument or the replacement of an existing one. This is an excellent resource for those seeking to practice or learn new skills. For piano students, playing in a band, iReal Pro is an optimal application to practice free accompaniment, and identify the appropriate rhythm for a variety of musical styles.

The features of application have been designed to facilitate the selective adjustment of volume for instruments, the modification of tempo during the learning process, and the instantaneous

transposition of the song. The iReal Pro application is considered as a highly effective tool not only for pianists specialising in classical music. It is characterised by ease of use and accessibility, at the same time facilitating a more profound comprehension of harmonies and their utilisation. Furthermore, the users are able to manually upload their own compositions in order to store it and select a suitable style for practicing.

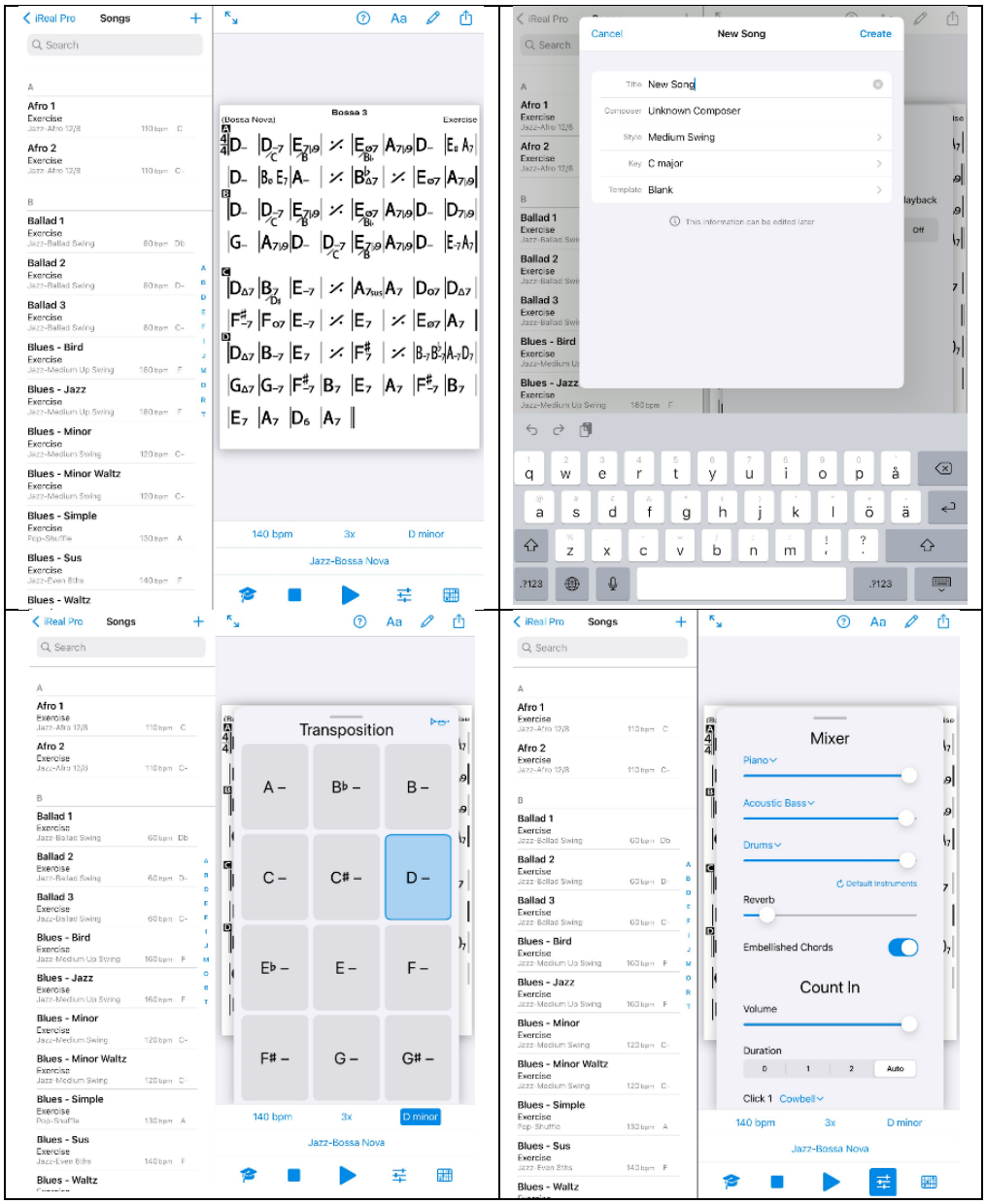


Figure 9. *iReal Pro Application*

*Note*. Screenshot by the author. The figure illustrates the iReal Pro application interface.

It is evident that contemporary society is characterised by a wealth of digital resources, including music applications and websites which are utilised for both educational and professional purposes, as well as personal growth. The objective of these exercises is to facilitate the development of musical skills, including listening, rhythm, theoretical knowledge and visual perception of musical notation. Consequently, the utilisation of such applications by students is beneficial, engaging, and, with the guidance of an educator, comprehensible and optimally effective. In the following section, notation software will be discussed in terms of the practical application of theoretical knowledge in a specific context.

## 4.4 Music Notation Software, Comparison and Usage

In relation to note-reading skills and the development of students' musical memory and cognitive abilities, the next stage of learning involves applying the acquired knowledge in practice. In the comprehensive music curriculum for Finnish music schools from 2017, the fundamental objective of introductory instruction is the cultivation of both an appreciation for music and the enhancement of musical aptitudes as a long-term endeavour. The concept under discussion suggests that musical aptitude is developed as an integrated whole, encompassing competencies such as listening, study, perception, application, and analysis, both individually and through collaborative activities, as well as composition, with an emphasis on self-expression and improvisation (Opetushallitus, 2017, pp. 10–12).

In the light of the above, it would be logical to utilise existing notation software for the writing of music composed by the student. Furthermore, research conducted on the use of music notation software has demonstrated that such application has a positive effect on the development of music reading skills in students. Moreover, the research findings indicate that students utilise music notation software with proficiency and satisfaction. Indeed, the utilisation of these tools confers dual benefits upon students. Firstly, they are engaged in the active reading of the text, and secondly, they are taking opportunity to contribute by writing their musical ideas. In this manner, the comprehension of the configuration of musical rhythmic patterns is cultivated and refined, alongside the utilisation of pauses in relation to musical sound. Given that all music notation software is equipped with audio playback functionality, students in addition develop a dual visual-auditory stimulus, thereby enhancing their ability to recognise and recall the connection between musical symbols and their corresponding sounds. Upon the entry of each new note, the student is

presented with the auditory experience of the note and later on the opportunity to listen to the complete phrase. When entering their own musical notation, the student is enabled to select the instrument and to experiment with tempo, dynamics, and rhythmic patterns, thus fostering the development of their creativity. The study demonstrated that the utilisation of music notation software is a significant impact within an educational framework, serving to enhance and supplement the learning process (Galera-Núñez, 2024, pp. 2–3).

A more detailed analysis of music notation applications reveals that after the cessation of development and updates of the popular Finale application, which musicians have been using for several decades, Sibelius and MuseScore programs became the most widely used. It is evident that a significant benefit of MuseScore for music college students is its cost-free and user-friendly nature. However, an alternative application that is worth considering is Dorico. Steinberg developed Dorico, which is available in three versions: Dorico Pro, Dorico Elements and Dorico SE. In addition, there is a mobile version for iPad. The last two versions are free.

## Dorico

The developers posit that Dorico is the optimal choice for writing music notation and composition, emphasising the presence of intelligent and time-saving functions. The programme has been the subject of active recommendation for educational use, for both students and teachers. Dorico is available for use on all platforms, including macOS, Windows and iPad. Paid versions offer a wide range of features, settings, instruments and sound options for professionals. However, the free version also allows students to create scores for up to 8 instruments, making it a great option for initial introduction and educational use.

In addition to the evident methods of employing music notation software to write musical text, educators have the capacity to take the initiative in preparing and creating individual exercises for their students. Please refer to Appendix 1 for the first three examples, which were created using the free version of Dorico Se. This is a great example of an individualised pedagogical approach. In this case, educators can design exercises and activities to address the specific needs of their students, thereby enhancing their competencies in areas that require reinforcement. Teachers may vary the difficulty of assignments from basic to more complex, including rhythmic patterns,

different key and time signatures, writing and reading notes in different octaves and clefs, and using various techniques available in music notation software.

### Soundslice

It is important to note that music notation programs can also be used online. Soundslice is an online illustrative example of this tool. In order to use the service, it is first necessary to register. The web-based tool is a free open source. Soundslice is highly accessible, with minimal complexity in examples and features, making it well-suited for young learners. In a similarity to professional music notation software, in Soundslice the user is able to select an instrument, duration, strokes, and listen to the written melody. The last two exercises in Appendix 1 were created using the Soundslice platform.

In general, it can be stated that music notation programs have similar functions, with minor changes in the interface and, naturally, a greater number of features in the paid versions. In consideration of the target group within the educational process, namely music college students, the necessity for simplicity and ease of use is prioritised. The fundamental objective of education is to stimulate interest and motivation in students, and to adopt an individualised approach to ensure their engagement and success. The selection of software is made in accordance with the objectives and requirements of the user.

## 4.5 Disklavier

The Piano Disklavier represents a new spin on the history of piano instruments, combining an acoustic instrument with contemporary technological advancements to open up a huge potential of possibilities for performers, teachers and piano education as a whole. In the 1980s, Yamaha Corporation invented the concept of integrating a built-in recording and playback system within an acoustic piano instrument. This is where the name of the instrument came from, combining the two concepts of Disk (disk) and Klavier (piano). The primary distinguishing and unique feature of disk recording is that it does not record the sound produced by the vibration of the strings but rather the mechanism of movement of the hammers. Electromagnets, also known as solenoids, have been integrated into the instrument's design. These electromagnets, or sensors, are strategically positioned beneath each hammer, ensuring precise monitoring of the nuances in play,

such as the time of pressing, the force applied, and the tonal quality. The sensors record these parameters and convert them into MIDI data, allowing the musical performance to be represented digitally. Sensors are also installed on the pedals and all moving parts of the mechanics for the purpose of ensuring more accurate recording and quality playback. The Disklavier concept is an exemplary illustration of the integration of optical, digital and computer technologies into traditional acoustic pianos. It breaks all stereotypes and conventional perceptions of instrumental performance, thereby fostering a respect for the integration of advanced technology in classical music. It is evident that the Yamaha Disklavier has undergone a series of evolutionary developments over nearly four decades. Each subsequent model and technological advancement has enhanced and expanded the instrument's capabilities to meet the current demands (Litterst, 2017).

In turn, Malykhina (2016, p. 145) emphasises several functions of how Disklavier can be used in the piano classroom. In her opinion, the Disklavier possesses fundamental functions, including pedagogical, auxiliary, technical and entertainment purposes. Since the focus of this study is on expanding pedagogical resources, therefore, the recording, playback, PianoSmart functions as well as connecting to a computer and working with MIDI files are of particular relevance in this case. The main function of the Disklavier is recording musical performances, with a focus on capturing performance details in MIDI format. The recorded data can then be processed to improve or analyse the material. Playback is made possible through solenoid sensors, which activate the piano’s internal mechanisms and allow it to perform automatically. Unlike digital pianos or audio recordings made with external devices, the Disklavier produces sound acoustically through the instrument itself. Since the performance takes place in real time, this feature allows for ensemble playing and immediate aural analysis of the performer’s own interpretation.

The PianoSmart function operates as an additional feature that allows music from CDs, USB devices, and studio or concert recordings by different pianists to be played back on the instrument using acoustic sound. This function allows the student to make changes to an already recorded concert performance by transposing or changing the tempo and volume. In this way, the student comes into personal contact with a professional performer. PianoSmart also allows students to explore various interpretations of piano pieces, which in turn improves their auditory, cognitive, and musical analysis.

Malykhina (2016, p. 146) notes that connecting the Disklavier to a computer increases its pedagogical value and expands the possibilities of recording and playback. In this way, MIDI files can be converted into visual diagrams, which facilitates a detailed study and analysis of the performance nuances.

The Disklavier plays a crucial role in the analysis of piano performance, particularly in helping students and teachers draw a more objective understanding of piano playing. Compared to performers on other instruments, pianists cannot see or observe their own playing. When analysing or evaluating their own performance, pianists are forced to trust their subjective feelings and inner impressions. However, in practice, audience often perceive a performance differently, noticing details and nuances that the performer themselves may miss. That is why the teacher-student model in piano education has not lost its relevance during the century of piano art. It is extremely important for students to have a teacher who can evaluate their performance, identify areas for improvement, and provide guidance for further development. Essentially, a student's evaluation depends on the teacher's subjective assessment, which analyses the student's performance or the immediate action performed, which no longer exists. The teacher's analysis is based on memories or feelings about the performance. This process depends on the teacher's impressions of the performance, which can vary from one observer to another. The situation is further complicated for a student by the fact that all analysis is conducted orally, which increases the missing information or interpreting it inaccurately. Introducing the Disklavier into this teaching context changes the way lessons are conducted. It transforms the overall nature of the lesson, concept of analysis and evaluation, and how students interact with the material review, ways that were not previously possible.

Malykhina (2016, p. 147) particularly emphasizes the ability of the Disklavier to record and accurately reproduce performances. For students, such analysis of their own performances allows them to move from the passive role of listener to an active participant in the discussion with the teacher. The instrument's large memory capacity makes it possible for both teacher and student to access recordings from the very beginning of practice. This helps to track progress and the sequence of completed work at different stages of learning, as well as plan future learning strategies. Thus, the performance becomes a shared object of analysis and reflection for both teacher and student.

According to Malykhina (2016, p. 151), this democratic approach between student and teacher contributes to the development of such personal student qualities as initiative, responsibility, reflection, self-criticism, creativity, and confidence. In music education, this pedagogical approach helps students actively participate in both the learning process and their own artistic development. For the twenty-first century learners, this is an essential component of personal growth.

As an alternative, the student's performance can be video recorded and then discussed and analysed together with the teacher. However, as noted earlier, Disklavier provides a more accurate and detailed reproduction of performance, which significantly improves the effectiveness and quality of the recording and, accordingly, the joint analysis.

On the other hand, the PianoSmart is a unique feature, exceeding all expectations and unlocks previously unused possibilities. It allows students to record and listen to the teacher's performance, then compare it with their own. Furthermore, when learning a piano part in an ensemble with orchestral parts, the student can begin playing with the Disklavier, replacing the orchestral part. This reduces the time needed for auditory adaptation to the perception of the orchestral part. Such approach ensures greater productivity in future joint sessions with the orchestra and allows the teacher to focus on the student's performance rather than on their own performance of the orchestral part during rehearsals. The list of advantages and functions of PianoSmart does not end there. The use of the pedal is a topic that has become the subject of debates and discussions among pianists due to the wide range of possibilities and gradations. The use of computer graphics of MIDI recordings allows students to visualize pedal movements, analyse its use, and easily compare it with the teacher's playing or with performances by famous masters. The undeniable advantage is that the entire performance can be perceived not only acoustically but also visually.

Since all Disklavier files are stored in MIDI format, they can be played on any computer without the need for a direct connection to the instrument. This opportunity goes beyond the classroom and extends to the home environment as well. This pedagogical approach supports the development of student initiative, independence, and creative exploration.

Beyond the traditional classroom, the Disklavier also proves a value for remote lessons and online master classes. Its ability to send and receive high-quality instructions, at the same time keep the feel of playing touch in real time is an important step forward in music education. This ability opens up the possibility for musical education and professional collaboration with the whole world.  This led to the creation of the International Disklavier Education Network. This network provides a platform where educators, performers, and musicians can collaborate, share experiences, exchange creative ideas, and discuss solutions to challenges that arise in rehearsals, performances, and distance learning.

Finally, the most remarkable fact about Disklavier is its ability to erase not only geographical but also time boundaries. Yamaha Corporation has demonstrated an advanced level of innovation in the realisation of the seemingly impossible. The Disklavier has been developed to such a degree of perfection that it is now capable of accurately reproducing the touch of any pianist, whether living or deceased (Yamaha Make Waves, 2017). A notable illustration of this phenomenon was observed during a concert held at the Tokyo University of the Arts in 2016. A chamber ensemble comprising four distinguished twenty-first century string players from the Berlin Philharmonic Orchestra performed the fourth and fifth movements of Franz Schubert's Piano Quintet in A Major. They were accompanied by the renowned twentieth century pianist Sviatoslav Richter, who died in 1997.

As previously discussed, the Disklavier system possesses the capability to reproduce a performance of a recording in an acoustic setting. In this particular instance, the objective of the experiment was not merely to replicate the performance of a virtuoso pianist, but rather to achieve synchronisation between musicians, facilitate a unified performance within an ensemble, and enable the musicians to perform in real time. In order to achieve this goal, the developers of the Disklavier implemented an advanced artificial intelligence (AI) system. It has been demonstrated that Yamaha AI Ensemble technology is capable of recognising each other's musicality, comprehending the intentions of the performer, analysing gestures and sound, movements, predicting subsequent notes and reacting harmoniously to the joint performance. Following analysis of the data presented above, the AI instructs the Yamaha Disklavier piano to perform the musical piece accordingly.

It is a well-established fact that visual contact facilitates mutual understanding of intentions and synchronisation amongst musicians playing in an ensemble. In order to compensate for the absence of a pianist on the Disklavier, Yamaha AI Ensemble technology employed a visual aid in the form of a projected shadow of an imaginary pianist on stage. The movements of this shadow provided visual cues to the rest of the ensemble, thereby facilitating synchronisation of rhythm and tempo. It is evident that the integration of Yamaha AI Ensemble and Disklavier's cutting-edge AI technology serves to broaden the instrument's functionality, thereby enabling the user to perform in unison with contemporary pianists and those who lived long ago.

In conclusion, it is evident that Disklavier occupies a valid and significant position within the context of contemporary piano art. This assertion encompasses a wide range of settings, including regular lessons, online lessons, master classes conducted by advanced teachers from any global location, and the analysis of one's own performance for pedagogical purposes or collaboration with other musicians within an ensemble. From a pedagogical perspective, Disklavier has been shown to expand the conventional view of classical piano performance by introducing innovative teaching methodologies that align with contemporary pedagogical trends.

## 4.6 Online Lesson Platforms

Online piano lessons are becoming more common and frequent among both professionals and as a part of basic education. In addition to regular remote lessons, this form of teaching can be a convenient solution in certain situations to fill in the gaps if a student is unable to attend class for any reason. In order to facilitate a lesson of the same standard as a regular in-person lesson, certain criteria must be taken into account. A number of factors have been shown to influence the quality of online lessons. Firstly, it is the age of the students and the ability of their guardians to organise the technical environment for learning. Despite the extent of a teacher's technical proficiency and preparation, it is important to acknowledge the participation of both the instructor and the students in the context of online learning.

The next important factor is understanding the specifics and nature of music lessons. It is no secret that sound delay or so-called low latency is a decisive factor in the perception of natural performance for remote music lessons, and even more, in real-time ensemble playing. According to research, a delay of 25–30 milliseconds is considered the maximum acceptable delay for remote

music lessons (Tsioutas & Xylomenos, 2023). In practice, all modern video conferencing programs transmit sound with a delay of 100–200 milliseconds, which is acceptable for speech but completely unsuitable for a real-time remote music playing. Since a distinctive feature of the piano is its stereo sound due to the left and right registers, which differ in timbre and balance, it is also necessary to consider the transmission of sound nuances, pedaling, dynamics, and strokes when choosing a platform for arranging remote lessons.

The majority of video conference platforms are designed with a primary focus on voice transmission, and these platforms typically implement a deliberate compression of sound to mono. This process involves the filtration of background noise and the reduction of echoes. In this case, piano playing is recognised by the software as a noise, and the use of a single video platform for the conference is found to be inadequate, as this results in a compromise of the quality of music reproduction. The most logical and natural solution is to use an additional low-latency audio exchange application in conjunction with the video conferencing application.

The MUSE-hanke project, a large-scale initiative that took place in Finland from 2021 to 2023, brought together specialists from various higher music education institutions to conduct in-depth research on this topic. Based on comprehensive research and testing, project experts identified various software applications with low threshold and low latency solutions, including SonoBus, JackTrip Virtual Studio, FarPlay, Jamulus, CleanFeed and SoundJack. When comparing these applications, the team members considered factors such as the lowest sound latency, ease of use, price, and technical criteria including sound quality, the possible number of participants, direct or additional server audio streaming, and built-in or additional features. Based on these tests, the project specialists recommend using several of these applications for online lessons due to their favourable price-to-quality ratio (Sallinen & Kujanpää, 2023).

One such application is SonoBus, a free application recommended for its ease of use and accessibility, and available on Mac, Windows, GNU/Linux, and iOS. However, as SonoBus is an audio transmission application, it must be used alongside video conferencing to achieve good sound quality for online lessons (Kujanpää, 2021).

The next application recommended by the MUSE project is FarPlay, which was developed by musicians for musicians, online lessons and collaborative music making. The application is compatible with all operating systems, including macOS, Windows, and Linux. In addition to ensuring low-latency audio transmission, the application also supports video, thereby eliminating the need for separate video conferencing software. FarPlay is accessible and user-friendly download process and intuitive interface. In contrast to Jamulus, it does not require additional server downloads, and it offers both free and inexpensive paid versions. The free version of FarPlay imposes restrictions on the time session frame and the number of participants. In addition to an expanded feature set, the advantages of the paid versions are that only the teacher, who initiates the session, needs to have the paid version, while the other participants or students can join, use the features, and even record the playing while remaining on the free version (FarPlay, 2024).

The third application recommended by the MUSE project is CleanFeed, which is available in both free and inexpensive paid versions. A distinctive feature of CleanFeed is its ability to function directly within the Chrome browser. Testers noted that sound quality was satisfactory during sessions. It has been asserted by several other sources that CleanFeed is to be regarded as an online audio studio (Kujanpää, 2022).

In practice, technical innovations are always flexible and changing, as application developers are continuously striving to find better and more convenient solutions. Over the past three years, for example, new applications for online music lessons have been released and existing platforms have been updated, taking into account previous shortcomings. As well as low latency, these updates include a user-friendly interface, ease of use, accessibility that considers musical characteristics and criteria, cross-platform integration, and collaboration tools that go beyond simple audio. These include video functionality within the same application, high-quality sound, and interactive sessions between teachers and students or groups of students. Other useful additions to the learning process include a calendar, schedule, PDF file sharing, and real-time annotations on sheet music.

One such application worth considering is the virtual platform for music lessons, RockOutLoud.Live (ROLL). Created specifically for music lessons by developer and musician Mike Grande, it was

officially released in 2023 after three years of testing. ROLL is compatible with PCs, Macs, laptops, and Chromebooks and is accessed via Google Chrome. One advantage of the ROLL platform is that students do not need to download it but simply follow a link. Students can also use mobile devices. ROLL supports video but prioritises high-quality sound. If there are problems with internet connection, sound takes priority over video, unlike other video conferencing applications (California Rock News, 2023).

In the ROLL, teachers can share integrated screen notes and chord symbols without leaving the main screen, in contrast to Zoom. There is no need to hold notes in front of the screen to show which part of the piece is being referred to. Furthermore, ROLL is equipped with an annotation tool that enables instructors to draw notes, chords, text and other symbols on a whiteboard. This information can then be saved in PDF format. ROLL has its own built-in library of licensed sheet music for various instruments, reducing search time when a spontaneous idea arises during a lesson and simplifying the process of finding the right music sheet.

ROLL asserts that the program is ethically sound, and that a stable connection between teacher and student is achieved by the system not using intermediate additional servers, thereby maintaining low audio latency. ROLL incorporates a chat function with emojis with which users are already familiar. The high-quality sound and naturalness of communication in ROLL are achieved through the use of full-duplex or minimally compressed audio, which enables simultaneous two-way transmission of sound. This feature is critical for the transmission of music (RockOutLoud, 2025).

In the ROLL, it is possible to select either Duet mode or Concert mode. Duet mode is intended for individual lessons, whereas Concert mode is designed for sessions or group lessons. In terms of financial considerations, ROLL offers a complimentary version, a paid monthly subscription for teacher-instructors at $9.95 per month for a single instrument, and a slightly more expensive multi-instrument instructor subscription at $13.95 per month (RockOutLoud.Live, 2025).

In order to create a virtual lesson in the ROLL, the teacher selects a musical instrument from six possible options. Upon opening a room designed for a specific instrument, the teacher will observe a toolbar situated on the left side of the screen, containing tools that are optimised for

that particular instrument. A link to the created lesson is then sent to the student, who can join the lesson without the need for registration or a complicated process of setting up and downloading the application. During the virtual lesson, the teacher has access to PDF sheet music from the ROLL library, which the student can download and save for themselves. Furthermore, the teacher has the ability to select any sheet music in PDF format from their computer, upload it to the program, and subsequently share it with the student (RockOutLoud.Live, 2025).

It is conceivable that ROLL may be considered to lack flexibility, multi-channel capabilities if such functionality is required for specific cases. However, on the whole, RockOutLoud.Live is a modern and targeted solution specifically designed for live remote music education.

In addition, here are a few words about two platforms that were developed specifically for teaching music online. One of these is Muzie, which presents itself as a powerful, interactive tool offering a variety of features to support teaching. It promises high-quality sound and video, as well as the ability to record and save lessons, use a whiteboard for notes, and access a variety of music templates and interactive games. It offers a comprehensive set of tools for organising music lessons, providing artificial intelligence assistance, creating personalised libraries, organising resources and tracking student progress. Furthermore, Muzie provides virtual spaces with a capacity of up to fifty participants for concerts or masterclasses. Students can see visual assignments, receive rewards, and easily track their progress. Muzie has a free version and a monthly subscription (Muzie, 2020).

On the other hand, SYNKii asserts that music teachers will find all the resources they need on this platform. It is a new platform that is developing rapidly. SYNKii offers a virtual keyboard for real-time playing, a music editor for writing and editing scores, and the ability to import and export MIDI, XML and PDF files. Teachers can also easily assign and mark homework. SYNKii supports video and provides seamless video and audio communication via a peer-to-peer connection. SYNKii is also compatible with most popular phones and tablets (SYNKii, 2024).

In light of the above, teachers always have the opportunity to choose an online teaching platform based on their own needs and resources. However, many sources note that regardless of the

platform chosen, there are a number of criteria and additional recommendations that should be considered when selecting technical equipment for online lessons.

The significant criteria to consider is the Internet speed and the configuration of the network. Topmusic co (2021) asserts that the utilisation of a wired connection to the router is imperative for the successful undertaking of online music lessons. Wi-Fi is an effective solution for downloading text and images, however, its capacity is not sufficient for real-time video online lessons. Therefore, it is advisable to employ a wired Ethernet connection via a fibre-optic cable directly through a router. A potential issue that may be encountered during the connection process is the absence of an Ethernet cable port in newer laptop or tablet models. However, this issue can be easily resolved by utilising an inexpensive adapter that facilitates the connection of Ethernet on one side and the USB port of a laptop or tablet on the other.

However, in practice, a survey of MUSE project teachers demonstrates that 85% of teachers connect to a wireless network during distance learning, only 22% use an Ethernet cable connected to a router, and 77% are satisfied with their internet connection for online teaching (Sallinen, 2021).

It is evident that fibre-optic cables are more appropriate for online streaming due to their superior download and upload speeds. In a 2021 study, Topmusic co. conducted a visual analysis of cable/DSL connectivity in comparison to fibre-optic cable technology. This analysis used a visual comparison to a system of roads, where speed limits indicated the different connection speeds for different cable technologies. The fibre-optic cable was pictured as a highway and symbolized maximum speed. In other words, this type of cable is the optimal choice due to its excellent speed and efficiency. The visual representation demonstrates that fibre-optic cables are much faster than older technologies (Topmusic co., 2021).

Data transfer speed is also affected by the router providing the Internet connection. Many routers do not have a QoS feature, which allows one device to have a priority when transferring data. When multiple devices are using the same network, this feature becomes important for maintaining stable and efficient Internet connection.

In a music lesson, sound and its quality play a crucial role in perception. Therefore, proper stereo sound settings are also necessary so that the student and the teacher can clearly hear dynamic nuances and the use of the pedal during playing. The correct sound adjustment contributes to an accurate analysis of the performance. Such platforms as Zoom, Google Meet or Microsoft Teams, for example, are designed for speech transmission and intentionally compress sound into mono and filter a noise. In this case, playing the piano is recognised as a source of noise. It is therefore necessary to check the settings and activate the "Original Sound" function in Zoom. In order to enhance the quality of sound perception, it is recommended that educators utilise two microphones: one for speech, and the other for the instrument.

A distinctive characteristic of the piano is its capacity for stereo sound, which is achieved through the differentiation of the left and right registers in terms of timbre and balance. For inexperienced students, it is sufficient to use an external USB microphone, as this provides a clearer sound than the built-in laptop microphone. However, for students at an advanced level, a single USB microphone may fail to meet their needs.

For a more accurate capture of the piano sound, two microphones can be used, connected via an audio interface that converts the signal to USB and transmits it to a computer. In this case, the teacher can perceive the true balance between the left and right hands, the depth and volume of the instrument, as well as nuances and pedaling. As for headphones, experience shows that simple wired headphones are the optimal solution for achieving fast and clear sound without echo.

The next point that is important to consider, piano teachers often make comments directly on the sheet music during physical lessons. This can be fingering, articulation, dynamics, and other important details. This is also possible in online learning using an iPad and Apple Pencil. The teacher can make comments in real time, which the student can immediately see. Regarding the camera, it is important to adjust it to different angles so the student can see everything the teacher is focusing on. Online lessons should include feedback, short videos, clear explanations, and constant progress monitoring. This helps maintain discipline and the quality of the lessons. Online learning encourages students to be more independent and responsible, helping them improve their listening and comprehension skills.

In conclusion, understanding how to use technology is helpful, but it is equally important to apply teaching methods adapted to the online environment. To transform a simple video call into a high-quality online music lesson, teachers need to adapt their teaching methods to the digital format. However, teachers are often lack of physical contact with students in online environment and should explain all movements and sensations verbally. At the same time, online lessons require longer periods of concentration, which can cause mental and physical fatigue in both students and teachers. To reduce this tiredness, it is important to carefully plan lessons, take short breaks, and provide clear and accessible information. Therefore, it is recommended to plan lessons with a clear structure and break them into shorter, more manageable sections. When teaching young children online, it is especially important to work closely with their parents and ensure their active support for effective learning.

## 4.7 Use of AI in Music Education

With technological advances, artificial intelligence is gaining increasing attention. People turn to it for advice and inspiration, seeking answers to their everyday questions. With its help, people can create images, bring ideas to life, and even compose songs. In the context of music education, it is especially interesting to consider how AI can support teachers and students in their daily practice and what opportunities it currently offers in music education.

As a responsible educator, the author considered it essential to understand the technical foundation and mechanism of AI before using it as a teaching assistant, delegating some teaching tasks, and recommending it to the students. According to IBM (n.d.), AI is defined as a comprehensive system consisting of several levels, including machine learning (ML), deep learning (DL), and neural networks. These in turn form the basis of deep learning algorithms. Neural networks can be categorised as either single or deep multilayered structures. The definition of AI is generally considered to be the imitation of human intellectual functions. This encompasses the capacity to discover, identify new information, draw conclusions, extract information from other sources that may not have been explicitly stated, and the ability to reason and understand things. In other words, AI models human abilities but does not possess them in the human sense.

Machine learning (ML), a significant component of this level, involves making predictions or decisions based on data or statistical analysis of the data provided to it. In other words, the

greater the quantity of data received, the more precise the analysis will be. Deep learning (DL) is characterised by the implementation of multiple layers of neural networks, which simulate the functions of the human brain. In the context of deep learning, it is not possible to track the entire work of the system. Despite the interesting conclusions and results achieved, in some cases it is impossible to determine the reliability of the information, because the method by which it was obtained is not known. Therefore, it can be concluded that DL is a subset of ML, and consequently AI is a superset of ML and DL together. Similar to the human brain, AI can analyse visual and audio signals alongside speech recognition and text reading, reflecting human perceptual abilities such as seeing and hearing (IBM, n.d.).

In particular, educational programs and applications, including those related to music, use both machine learning (ML) and deep learning (DL), as well as neural networks. Since these technologies are similar, in practice they are often combined under the general term artificial intelligence (AI).

The next step is to consider using AI as an assistant in daily practice for analysing musical performances and providing feedback, since feedback is an integral part of the learning process. Whether it uses machine learning (ML), deep learning (DL) or neural networks, it is important to understand and remember that the program will work with and process various types of information or data. Evin (2024) therefore argues that AI can easily cope with physically measurable data, such as rhythm and dynamic accuracy, and with comparing the correctness of note performance with the score. This is because notes have a frequency and timing, and sound amplitude is easily measurable. If an application based on one of the levels of AI receives a data stream via a digital piano connected to MIDI, it receives ready-made recorded data. However, this is more difficult along with a microphone because an audio analysis must first be conducted, after which synchronisation with the score and further analysis are possible.

The situation becomes more complicated when it comes to artistic evaluation. AI relies solely on data rather than context and aesthetics. Consequently, AI currently demonstrates limitations in interpreting musical context and aesthetics. At the same time, Merchán Sánchez-Jara et al. (2024) confirm in their research that introducing AI into music education personalises it for students with different experiences and skill levels, promoting interactive and effective learning. In practice,

using AI tools encourages a creative approach to learning and enhances traditional teaching methods.

Turning to a practical illustration of the implementation of AI technologies, the focus will be made on Pianolympics, one of the basic yet beneficial application for piano training. This web service, created by musicians for musicians, is specifically designed for the purpose of practising scales and arpeggios. The application is available as a browser version and as an iOS app. An Android version is currently being tested. In order to initiate the process, it is necessary to connect a MIDI keyboard to the computer. Thereafter, the connection to the application is established automatically.

Pianolympics reads the playing via MIDI and provides instant feedback in the form of visual graphs and indicators. It analyses parameters such as rhythm, dynamics, articulation, hand synchronisation and sound evenness. The application highlights details that often go unnoticed by students when practising on their own and helps to identify technical shortcomings.

Pianolympics does not indicate fingering or teach music notation, as it was originally designed as a tool for technical practice. The website emphasizes that the application is designed to complement lessons with a teacher, not replace them.

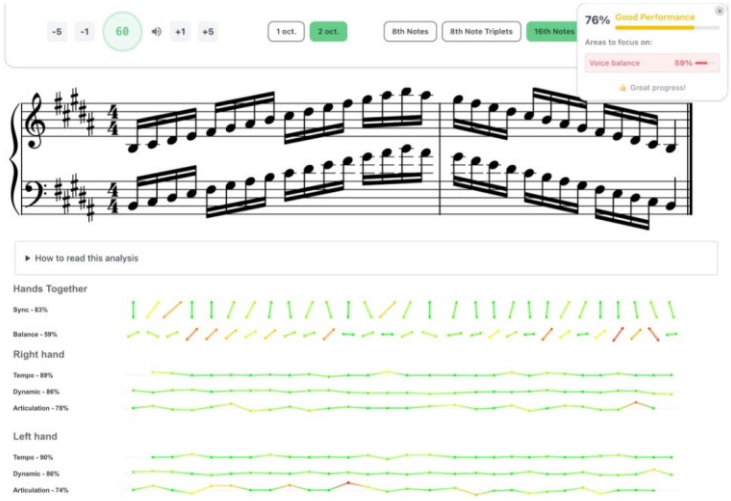


Figure 10. *Pianolympics Application Interface*

*Note.* Screenshot by the author. The figure illustrates the analysis of scale playing in Pianolympics application.

The next noteworthy application is PianoTracker. Created by Florian Grundig and released in spring 2025, this application is currently available to download for free from the Apple Store for iPhone, iPad and Mac devices. Designed specifically for piano lessons, PianoTracker focuses on practical work for students. This AI-powered application helps students to read sheet music correctly and practise playing with one or both hands. It connects to a digital piano or MIDI keyboard and provides instant feedback, automatically highlighting mistakes in red in the sheet music. In PianoTracker, the transposition of a piece to any key is a simple process, and the addition of fingering to the sheet music can be done with ease. The application has the capacity to save up to 200 recent performances of each piece, thus enabling the user to track progress, analyse the dynamics of lessons, and share results with the teacher. Within the personal account, a student can create folders to organize a learning material.

The application's integrated library already contains over 1,000 pieces from the repertoires of such composers as Bach, Chopin, Handel, Gannon, Mozart, Beethoven, and Schumann, which have been classified according to level of difficulty. Furthermore, users can import their own pieces in MusicXML format (.xml /.mxl), or from MuseScore or similar music notation editors' platforms. PianoTracker is a truly practical, accessible, and modern platform that makes the learning process individual, flexible, and engaging.

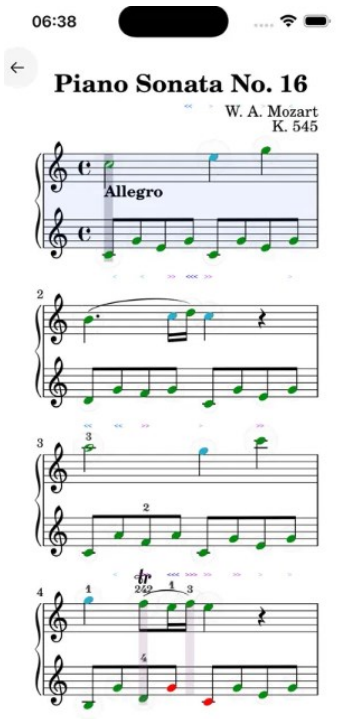


Figure 11. *PianoTrackers Application Interface*

*Note.* Screenshot by the author. The figure illustrates the immediate feedback provided by artificial intelligence.

Similar features can be found in Piano Marvel, a software created by Americans Aaron and Heidi Garner in 2009. According to Piano Marvel (2025), Aaron Garner is a professional pianist and teacher who was inspired by observing young students showing an interest in technology and video games. This interactive application is constantly updated to meet the challenges of the times, and is currently available to download on iPhones, iPads, Windows devices, Macs and Chromebooks.

Piano Marvel offers a free version with limitations, as well as inexpensive monthly ($17.99) and annual ($10.84 per month) subscriptions. In addition to an extensive library of over 1,000 musical works of various genres and levels, including popular editions, the application contains over 3,000 exercises for developing technique and a constantly growing number of video lessons with step-by-step instructions.

A unique tool for developing sight reading skills occupies a special place. The program's algorithm selects excerpts in gradual progression and tracks the results in tables. Students can clearly

observe and improve their results by completing over 1,000 excerpts divided into 90 levels. In game mode, the program assigns awards and grades, which motivates the learning process and provides instant feedback, accurately determining the correctness of notes and rhythm. Piano Marvel enables the user to upload sheet music files, create music collections, organise them into chapters, and arrange them in any order. This functionality is merely a component of the application's broader capabilities. In addition to facilitating individual practice, the application operates as a virtual learning environment, offering online lessons, group classes, and real-time collaborative play without latency. Subsequent to the creation of a new session, the teacher has the capacity to extend invitations to students to participate by means of a designated code (Piano Marvel, 2025).

Piano Marvel is a software application that enables the user to track the number of minutes spent practicing, the regularity of practice, and to visualise progress. This platform offers a wide range of features, making it a useful resource for both teachers and students.


Figure 12. *Piano Marvel Application Interface*

*Note.* Screenshot by the author. The figure demonstrates scores and results of practicing.

There is a clear positive trend in the development of technologies and platforms for music lessons. Developers continue to improve these applications by addressing earlier limitations. AI-based systems already show practical value and can serve as a useful aid for home practice, especially when it comes to monitoring performance accuracy. At the same time, it is important to recognize that synthesized sound and automatic performance processing in educational applications still sound mechanical and cannot capture the acoustic sound of a live performance. These limitations should be considered when giving guidance or recommendations to students. Nevertheless, measurable parameters such as rhythmic and note accuracy can already be successfully analysed and significantly support the learning process.

Consequently, contemporary practice demonstrates the benefit of educators being open to experimenting with AI platforms in the learning routine. The implementation of such tools in practice assists not only in expanding the methodological arsenal, but also in enhancing student motivation, while acknowledging the leading role of the teacher in the creative and artistic aspects of teaching. Artificial intelligence works effectively with rational, formalizable aspects and sequences of actions, but music, like teaching itself, remains an art form in which there is a living element of irrationality, intuition, and artistic intention. This expressive, creative spark, the individuality of interpretation, and the authorial principle are unique characteristics only to human perception and consciousness.

# 5 Research Outcomes

The following chapter provides a comprehensive overview of the primary conclusions and findings drawn from in-depth interview with a leading expert in a field. The interview was focused on the significance, features, functions and demand for Disklavier in the Finnish educational environment. The chapter also presents practical feedback and results from piano department students after a year of employing educational music applications and music theory games in their practice as well as perspectives of fellow piano department colleagues.

## 5.1 Analysis of an Interview with a Disklavier Expert: Central Insights and Findings

The interview with the Disklavier specialist was conceived by the author as an integral component of the research, with the objective of obtaining expert opinion, empirical comments based on the specialist's practical experience, and a pragmatic perspective on the subject of introducing innovative technologies into the field of classical piano art. It was essential for the author to comprehend the function of contemporary technologies, particularly the Yamaha Disklavier, within the context of current piano pedagogy. Furthermore, it was imperative to explore the potential opportunities and limitations of such instruments in the educational setting. The objective of the interview was also to identify technical and pedagogical challenges, for example in distance learning, as well as to gather information about the acceptance of Disklavier in Finnish educational institutions. In addition, it was also important to hear the expert's opinion on the future prospects and trends in the development of hybrid pianos.

An interview was conducted with a highly qualified specialist in hybrid instruments in Finland. The author is grateful for the expert’s time and willingness to contribute to this project, despite a busy work schedule. The author chose the semi-structured interview format because it provides flexibility in the conversation, enables the addition of questions, and prompts reflection. In the author's opinion, this type of interview offers a profound comprehension and reveals the topic in more detail.

The interview was conducted as a scheduled meeting via the Teams platform and lasted 45 minutes. The primary benefit of employing Teams meetings is the convenience of organizing and conducting the meeting, in addition to the functionality of video recording and immediate transcription. The list of interview questions was sent in advance for review. The list of interview questions can be found in the appendices (see Appendix 2).

To analyse the responses, the author uses category coding to specify conclusions and notable findings. Since the field of study in this work is the pedagogical aspect, findings from a pedagogical point of view are of particular interest. The author set four main areas for study: the potential of the instrument in pedagogy, the technical capabilities of the instrument and its limitations, how actively and effectively the Disklavier is in use, and further prospects for hybrid instruments.

## Pedagogical aspects

Consequently, the first five questions are addressed to and focused on pedagogical aspects. The expert confirms that Disklavier has a unique range of potential capabilities and contributes positive qualities to classical teaching methods. In addition to its established applications in distance learning, Disklavier has the potential to be a valuable tool in the classroom settings, particularly when both teacher and student are in the same physical space. Instrument's recording and playback functions can facilitate collaborative analysis and enhance the joint learning experience.

The interviewee emphasises the playback function as the Disklavier's best feature. One of the key points and technical advantages of the Yamaha Disklavier Pro version is its ability to record and reproduce MIDI data at a very high resolution. Standard MIDI systems usually record performance data, such as key velocity, pedal movement, using 128 discrete steps. In contrast, the Disklavier captures this data with a resolution of approximately 1,000 steps. As a result, the instrument can record and reproduce fine differences in dynamics, articulation, and pedaling with a high level of accuracy. In other words, the Disklavier reproduces recorded performances providing a more precise representation of the original performance than with standard audio or video recordings do.

From a pedagogical perspective, this level of precision is highly valuable for detailed performance analysis and teaching. Students can listen to an accurate recording of their own performance, which allows them to notice and analyse their own playing and detect the inaccuracies which might otherwise go unnoticed. Teachers, in turn, can also use the recordings for comparison and joint analysis. As the interviewee noted, this feature is a powerful tool for both self-assessment and teacher-guided learning. During the conversation it was concluded that this approach increases the effectiveness of students' independent work and their motivation.

Therefore, in connection with the research question, the use of the Disklavier demonstrates how modern technology can be meaningfully integrated into twenty-first century piano pedagogy not as a replacement for traditional instruction, but as a tool that enhances motivation, supports independent work, and facilitates an interactive learning process, meeting contemporary educational needs.

Discussion of using the Disklavier in distance learning revealed a significant advantage. The common problem of audio latency in online piano lessons is eliminated. When playing together remotely, the pianist plays directly on and with the Disklavier, rather than with another musician via audio transmission. As a result, potential delays in signal transmission do not affect the synchronization of the performance, and ensemble performance occurs in real time. The same principle applies to concerts and livestreams, where a performance played in one location can be simultaneously played on Disklavier instruments in multiple locations. This synchronization is achieved through MIDI data transmission. According to the expert, this principle can also be successfully applied in the educational environment for interaction between music college teachers both within the country and abroad with their foreign colleagues. Master classes or concerts can be successfully organized for schools in one or even several regions. This approach undoubtedly broadens the understanding and possibilities of using Disklavier in education and teaching. The interviewee repeatedly emphasizes that much depends on “enthusiasm and creativity” of educators.

## Technical Capabilities and Limitations of the Disklavier

The next category is the technical capabilities of Disklavier and possible limitations. It includes questions 1, 6, and 8. As mentioned above, the Disklavier reproduces accurately all nuances of performance: dynamics, sound expression, articulation, various pedaling techniques, tempo, and register range, as well as providing acoustic stereo performance.

The expert in a field finds no disadvantages in the instrument, except for its high price. If teaching or performing takes place online, it is necessary for both parties on either side of the screen to have a Disklavier instrument. If the lesson takes place in the same physical space, then one Disklavier is, of course, sufficient for meaningful collaboration. Moreover, since Disklavier precisely reproduces the pianist's performance, when combined with video streaming, it creates an almost complete sense of presence, as if the performance were happening in the same physical space.

As for technical issues, according to the expert, using hybrid and digital instruments can present certain technical and organizational challenges. Consequently, users require basic knowledge to set up connections. However, technical support from providers can resolve most issues.

The expert also confirms that there is currently a high demand for Silent and TransAcoustic pianos. These instruments offer a hybrid solution that combines acoustic and digital functions. They function like traditional acoustic instruments while also reproducing digital sound through the instrument's body. The interviewee notes that this is truly impressive technology. It allows not only to enjoy the natural acoustic timbre of the piano, but also to use a wide range of digital timbres and various instruments. In addition, TransAcoustic instruments are equipped with recording and MIDI function allowing users to save their own performances. These capabilities of the latest generation of instruments allow musicians to choose between acoustic and digital modes, depending on their needs and preferences.

Nevertheless, music schools still prefer classical acoustic pianos. However, from a pedagogical perspective, the technical capabilities of modern hybrid and digital instruments expand the traditional teaching model, making it more flexible and personalized. Hybrid instruments combine acoustic sound quality with digital resources, preserving the value of the classical performance while integrating modern technology into the learning process.

## Interest in the Disklavier and Technological Innovations

Questions 7, 9, and 11 focused on the interest in Disklavier, its application, and attitude to other technical innovations in the Finnish professional music community. The interviewee noted that the Disklavier is not as popular in Finland as in other parts of Europe and believes that this instrument and its technical potential could be more actively used in Finland.

The interviewee is convinced that teachers are sometimes wary of new technological ideas, often due to a lack of knowledge about how to work with them and how to fully utilize their potential. This natural transition must be accompanied by training and instruction. In digital pianos, the acoustic sound is only imitated, which sometimes causes scepticism among piano teachers. After all, such instruments are based entirely on digital technology and do not contain real acoustic components. Hybrid pianos, on the other hand, offer an important combination of acoustic and digital technologies. They combine traditional hammer mechanism and authentic keyboard feel with digital sound, expanded capabilities, and support for connection to electronic devices.

In addition to the Disklavier, Yamaha provides the ENSPIRE Controller application, which has built-in teaching materials to help users to learn musical pieces. Nevertheless, the expert emphasised that technological innovations can greatly enrich pedagogical practice, but cannot replace a live teacher, their experience, intuition, individual approach to the student, ability to motivate and adapt teaching to specific tasks. This idea directly resonates with Evin (2024) and Merchán Sánchez-Jara et al. (2024), who argue that technology should be understood not as a key solution, but as a tool or additional resources for expanding teachers' pedagogical capabilities.

## Trends in Digital and Hybrid Pianos

Regarding the tenth question about new trends in the development of digital and hybrid pianos and their use for educational purposes, the interviewee expressed an objectively positive attitude and confidence in the further development of digital technologies:

*I see the tendency in development and growing more, especially in the cases where pianists can use both acoustic and digital parts of the instrument. For example, upright pianos may have a built-in sensor screen, where a musician can download directly from the internet or use a browser for music sheets.*

Instead of using a separate tablet or application, a digital display can be integrated directly into the body of an acoustic instrument. Similar models have already begun to appear, but they are not yet available on the Finnish market and are still in the active development stage.

The expert noted that new technologies in the field of classical art are designed to enrich the educational process and bring freshness to it. In conclusion, as a challenge and an inspiring wish, the interviewee expressed the following opinion: "I want to encourage everyone to be open-minded and enthusiastic about new technologies, get to know them and do not be afraid."

The interview confirms that the development of digital and hybrid pianos is viewed by professionals as a promising direction that could significantly expand both performance and educational opportunities. According to the interviewee, the most important factor is the openness of teachers and students to new technological solutions, at the same time following the traditions of academic performance. It is essential to emphasize that no technology can replace

live contact between students and teachers. However, tools that can inspire, motivate, and open up new horizons become powerful partners in the hands of thoughtful educators. It is important to remain open to new experiences and to embrace opportunities.

## 5.2 Feedback From Students

The practical use of music educational applications and platforms was tested throughout the 2024-2025 academic year with 32 students aged 7 to 18. The author spent time with each student individually presenting the applications, platforms, and other technical tools. It was assumed that students would complete the levels independently at home in a playful manner as a supplement to their homework. The main focus was made on reading notes in different registers, sight-reading, reading rhythmic patterns, identifying intervals and key signatures, developing ear training, and learning musical terminology. All 32 students enthusiastically embraced the new homework assignment: their eyes sparkled, they demonstrated excitement in class, and after just one or two examples, the students were actively engaged in guessing the tasks and managed them on their own. Even those students, who struggle to memorize the location of notes on the keyboard and musical terms, surprisingly showed sincere interest and enthusiasm in completing the tasks and became frustrated if they did not get 100 percent of the answers correct. They repeated the level multiple times to achieve the desired result.

Over the following months, the author monitored and inquired whether students continued to use the applications and music education programs at home. In addition, communication was also carried out through parents, who were provided with links to assist their children in downloading the applications or utilising them on their home computers. None of the 32 test participants purchased the paid versions. With the consent of their parents, a decision was reached to utilise the free versions of the applications. Both web browser and mobile versions were equally popular. Of the 32 students, only one had restrictions on computer use imposed by their parents as a house rule. However, with their parents' permission, a student was allowed to complete levels on their phone several times a week. The students selected a range of applications for mobile devices and computers, including PianoNanny, Musicca, Earmaster, PerfectEar, and MuseScore. One advanced student practiced with iReal Pro to improve the sight-reading of chords and free accompaniment playing for different styles of music.

All 32 students were proficient in Finnish, with 27 of them being native speakers, one student having an English-speaking background, another having a German-speaking background, and three students having a Russian-speaking background. Despite the variation in age, no participant experienced any language difficulty in using the applications. In the context of browser solutions, it is possible to configure the automatic translation of website pages into the user's preferred language. The utilisation of this feature by younger Finnish-speaking children was assisted by their parents. All students participating in the testing were of school age and able to read the assignments. It was revealed that students invest more time in theoretical games during the summer holidays. The empirical evidence provided by parents and students' teacher indicates that students have become more confident and less hesitant when analysing new compositions. After a year of utilisation of educational music platforms, it was observed that none of them require the teacher to provide a comprehensive explanation of a new piece before it can be practised. Students have been demonstrated confidence and self-assurance in their approach to independent study of new pieces. This has been shown to have a positive effect on the atmosphere of the lessons and the speed at which new material is learned.

Below are some statements collected after several months of using the applications and music games. The responses have been systematically organized and classified into the following categories:

1. Feedback from parents of students.

   "Previously, it was hard to take my child away from the phone. Now, although he still spends quite a bit of time on it, I am reassured that he is learning rather than just wasting his time."

   "Piano practice became a pleasure for our child, not a duty. For us, parents, this is the most important thing."

2. Student feedback on motivational and emotional impact.

   "I like it when I manage to answer correctly or complete a task. It means I am getting better at understanding musical terms."

   "Playing music games is fun."

   "I like to practice in a game format."

   "I discovered that my friend was also studying on the Musicca website, her teacher recommended it. We started discussing the assignments together, and it was really interesting."

3. Student feedback on educational impact.

   “I feel much more confident, especially when reading notes in the bass clef.”

   “I like that the tasks are categorized: rhythm, instruments, ear training, theory, and exercises. I can choose what I feel needs more development.”

   “I like that I can compose my song in MuseScore. It was difficult at first, but now I can do it. I can listen to the melody right away and fix anything I do not like. And the printed text looks like professional.”

   “I practice regularly, first on my phone, then with an instrument. I can really feel and see the difference. The music text is much clearer now.”

   “Playing music games is not difficult, instructions are clear, and it helps me to learn and understand music better.”

   “I started to hear the differences in registers. I think I can find the right sound on the piano now.”

One of the statements suggest that Musicca is already a part of pedagogical practice and is being used independently of this study by another teacher.

From the perspective of an educator, the author has observed a change in students' ability to read musical text. Students began to notice more details in the piece, such as dynamics, markings, strokes and fingering. During testing, students demonstrated their knowledge and ability to recognise tempo changes and musical expressions. Students reported that they could successfully perform short rhythmic fragments in the educational application, even when the patterns were relatively complex. They were able to recognize similar rhythmic patterns in full musical pieces, however, the use of these patterns in the context of a complete composition often required guidance from the teacher. In other words, students managed complex rhythms in isolated exercises independently, but more advanced rhythms in musical compositions presented challenges and required teacher’s support.

It was evident that students experienced positive emotions when engaging with the music games and applications, and they were willing to utilise these games as an additional resource for their home practice. Students showed significant self-confidence and increased theoretical knowledge during testing. This, in turn, had a beneficial effect on their analysis, comprehension, and speed of the pieces they learned. The introduction of digital tools also had a positive impact on the students' mood. At the same time, testing showed that applications and games could not

completely replace the teacher's guidance. Students gained independence in studying musical notation, but not musical interpretation, and needed explanations on how to apply their knowledge in practice.

In addition to specialized music applications, the study also explored the use of simple digital tools created by the teacher. Two crossword exercises were designed using the Excel program and are included in Appendices 3 and 4. Although Excel is not intended for music education, its use clearly demonstrates how it can be applied to create interactive learning activities. Such approach emphasizes the importance of teacher' creativity and demonstrates that technology can be integrated into music education without only relying on educational music platforms or paid software.

## Feedback From Teachers

Regarding feedback from piano colleagues, reactions to the use of digital technologies were mixed. The author prepared a presentation as part of the study with examples of mobile and browser applications. It was expected that this topic would generate professional interest and lead to discussion at a piano department meeting. However, there was a lack of interest during the meeting, despite the fact that some colleagues had previously mentioned the potential usefulness of free digital tools. As a result, some of the colleagues preferred traditional printed materials, and digital tools were not considered as a priority in their current teaching practice. Other members of the department did not take a clear opinion on this issue. Due to this reaction, the expected planned discussion did not take place.

In contrast, completely different reaction followed from the piano colleagues at another music college. Their responses were instant, positive, and indicated a high interest and openness to the use of digital technology. Currently, neither they nor their students use applications or educational music platforms in learning and teaching. Piano colleagues expressed interest in continuing professional discussions on this topic. This difference in perception can be explained by the human factor or differences in professional culture. Such factors are important to consider when studying how digital tools are used in music education. This different attitude among fellow pianists echoes the expert's opinion in the interview about the teachers' own readiness for new solutions and openness to using new tools in teaching practice.

# 6 Discussion/Conclusion

The main goal of the study was to find an innovative approach in the methodology and pedagogy of classical piano, taking into account modern technological possibilities. Special attention was paid to the use of educational music platforms, game-based learning applications with elements of instant feedback, as well as technologies based on artificial intelligence. An entire chapter of the study was devoted to the Disklavier, as its features and capabilities for pianists meet various of needs, from musical analysis of a composition to online lessons and master classes. The interview with the expert focused on the technical possibilities of the Disklavier and latest piano models. Therefore, the main research question was how to effectively integrate modern technologies into piano pedagogy in order to increase the interest and motivation of students, as well as expand the pedagogical arsenal of educators.

Based on the theoretical framework and literature review, it becomes evident that the multifaceted and complex process of learning piano is based on many factors (Worschech et al., 2024, pp. 1–2). First, there is the introduction to the world of musical sounds, followed by the development of theoretical knowledge and the ability to read and recognize musical notation (Thompson, 2018). Then, consistently and methodically, students learn to use various technical elements and extract different sounds from the instrument, depending on the context of a musical piece (Jacobson, 2006, p. 8). Together with a diverse and pedagogically well-structured repertoire, students master numerous forms of expressing the meaning of a composition through acquired skills (Barysheva, 2021, p. 83). This is a meaningful and extremely interesting process through which the students' personality, character, and perseverance are shaped. At the same time, students develop their cognitive skills, musicality, flexibility, ability to listen and to hear, as well as consciously manage their own performance, analyse, and understand what they are doing.

Despite the fact that digital technologies are a relatively new approach to teaching classical piano, the development and refinement of the above skills, as demonstrated study, logically and naturally fit into the educational environment with the use of innovative technologies. Measurable components such as ear training, rhythm, and theoretical skills can be effectively practiced using music applications and online educational platforms. Through these tools, students receive immediate feedback and are able to independently complete these types of tasks. Moreover, the empirical testing revealed that, alongside the development of musical knowledge, students' self-

confidence, discipline, and motivation also increased, which has a positive impact on the learning process.

On the other hand, the aesthetic side of piano performance, the artistry and individuality of each performer, and the development of musical potential do not fit within the algorithms of educational music platforms. In this case, the study proves that the classical teacher-student model remains relevant. The teacher takes an individual approach to each student, designing a personalized program that nurtures student's strengths. At the same time, technology expands the teacher's access to online materials, performances, and digital tools that can be used to enrich the student's repertoire and learning experience. Therefore, successful implementation depends on teachers' readiness to apply latest digital tools, as well as their professional curiosity and interest. This conclusion is supported by the interview with the expert, classroom observations, and the results of students' testing conducted during the study.

The findings of this study also show clear potential for further research and practical use of technologies in the field of music education. The author considers at least three promising areas for further research. First, it would be logical to conduct an experimental study comparing two groups of students. One group would practice the traditional piano teaching model, while another would use the integration of digital applications, artificial intelligence technologies, and the Disklavier instrument in their practice. This would allow researchers to objectively evaluate differences in progress, motivation, and performance skills. Secondly, the current study focused on the school-age students. As a next step, it would be interesting to examine how technology influences different age groups, from children and teenagers to music college students and adult beginners. This would provide an opportunity to compare motivation, the pace of progress, and technical skills in different age groups. Finally, the emotional aspect of music education is of interest. Since the results of the study demonstrated that musicality cannot be fully described or reproduced by algorithms, exploring the emotional connection with music could be a promising direction for further research. In particular, it would be essential to examine whether technological tools can enhance emotional connection with music or, on the contrary, make the process more mechanical.

In conclusion, the testing and implementation of educational programs, music applications, and interactive games were well-received by students. Students demonstrated higher engagement, increased motivation, and improvement in learning outcomes. These results indicate that thoughtful use of digital tools in teaching can contribute to students' musical skill development and learning. At this stage, students, their parents, and teachers have expressed interest in free platforms and applications. Nevertheless, this interest represents a meaningful starting point. In addition, from the perspective of environmental and economic sustainability, the testing of the music platforms and applications was conducted only online, without the use of printed materials and through freely accessible platforms. Accordingly, no resource-intensive or cost-demanding materials were employed in the implementation of the study.

The current market already offers a growing range of digital resources that are regularly updated. As with other areas affected by technological development, music education requires constant monitoring of new tools and trends in order to keep up with the times and meet contemporary learning environment.

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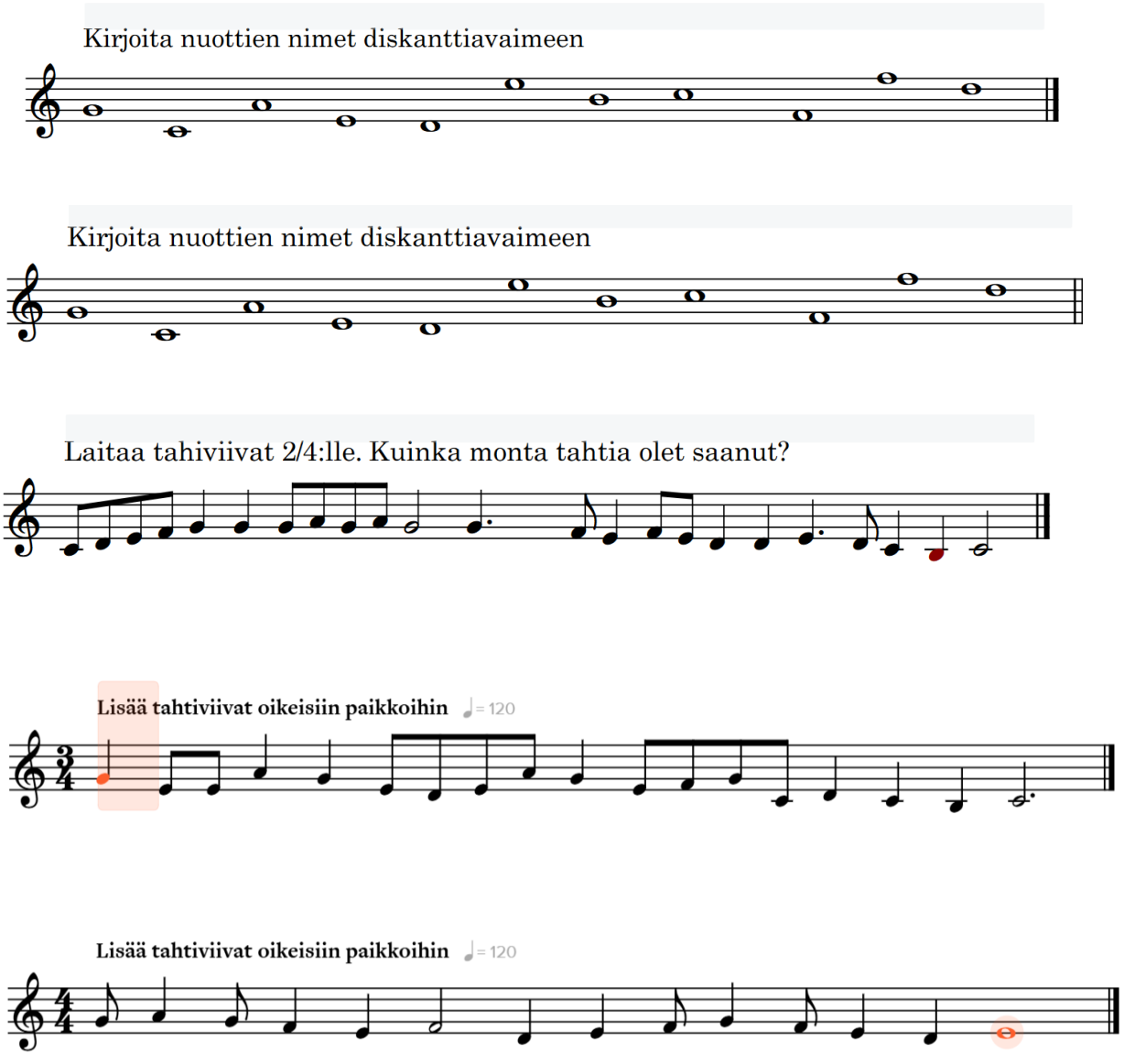
# Appendices

## Appendix 1. Individual Exercise Made with Dorico SE and Soundslice



## Appendix 2. Interview Questions

1. Based on your experience, how would you assess the role of modern technologies, including the Yamaha Disklavier, in today's piano pedagogy? What is the significance of the Disklavier in teaching compared to traditional acoustic pianos—what does it add, and does it have any limitations?

2. Which features and functions of the Disklavier do you find particularly useful in piano teaching?

3. How accurately can the Disklavier reproduce the nuances of playing – dynamics, pedaling, articulation? How does this affect learning?

4. Are there any special features that distinguish the use of the Disklavier in teaching situations from its use in concert performances?

5. What technical and pedagogical challenges arise when using the Disklavier in distance learning?

6. How does Yamaha or F-Musiikki solve the challenges related to sound wave speed and sound delays in order to maintain accurate real-time sound quality in teaching?

7. How actively is the Disklavier used in Finnish educational institutions (academies, universities, polytechnics, music schools, private schools)?

8. What challenges are generally associated with the introduction of such instruments in schools or higher education institutions – technical, financial, organizational?

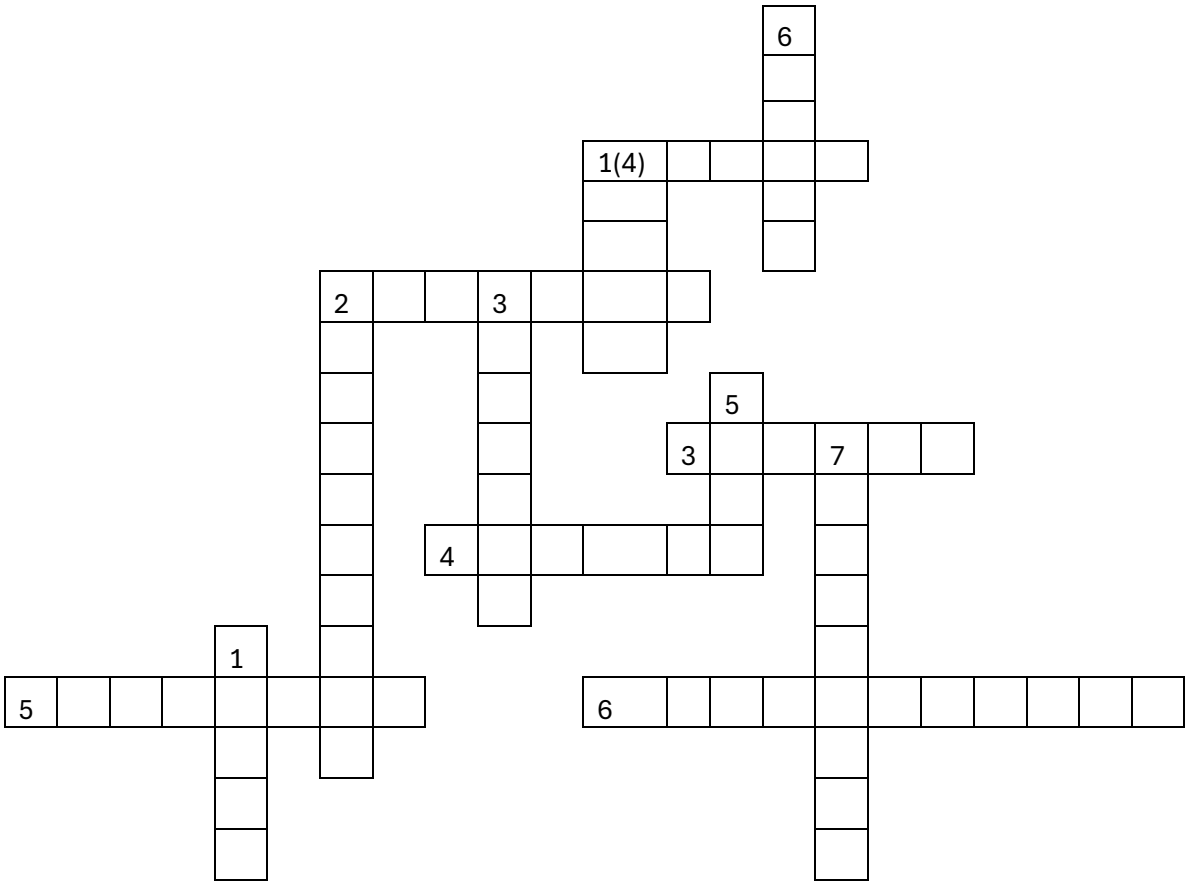
9. Are teachers ready to switch to using such technologies, or is there resistance?

10. What trends do you see in the future development of digital and hybrid pianos? What are the prospects for the use of hybrid instruments in music education?

11. What advice would you give to teachers who are just beginning to explore the integration of technology into piano pedagogy? What issues should educational institutions consider in terms of logistics and technical maintenance of hybrid instruments?

## Appendix 3. Crossword: Tempos Made with Excel

Ristisanatehtävä: Temput




Vaakasuunnassa:

1. Leveästi
2. Käyden, tasaisesti
3. Vikkaasti
4. Nopeasti, kiireisesti
5. Kohtuullisesti
6. Nopeampi kuin Presto

Pystysuunnassa:

1. Raskaasti
2. Hitaampi kuin Allegro
3. Iloisesti, nopeasti
4. Hitaasti, verkkaan
5. Nopeasti, mitä ennen Vivace
6. Kohtalaisen hitaasti
7. Hieman nopeampi kuin Andante

Vastaukset:

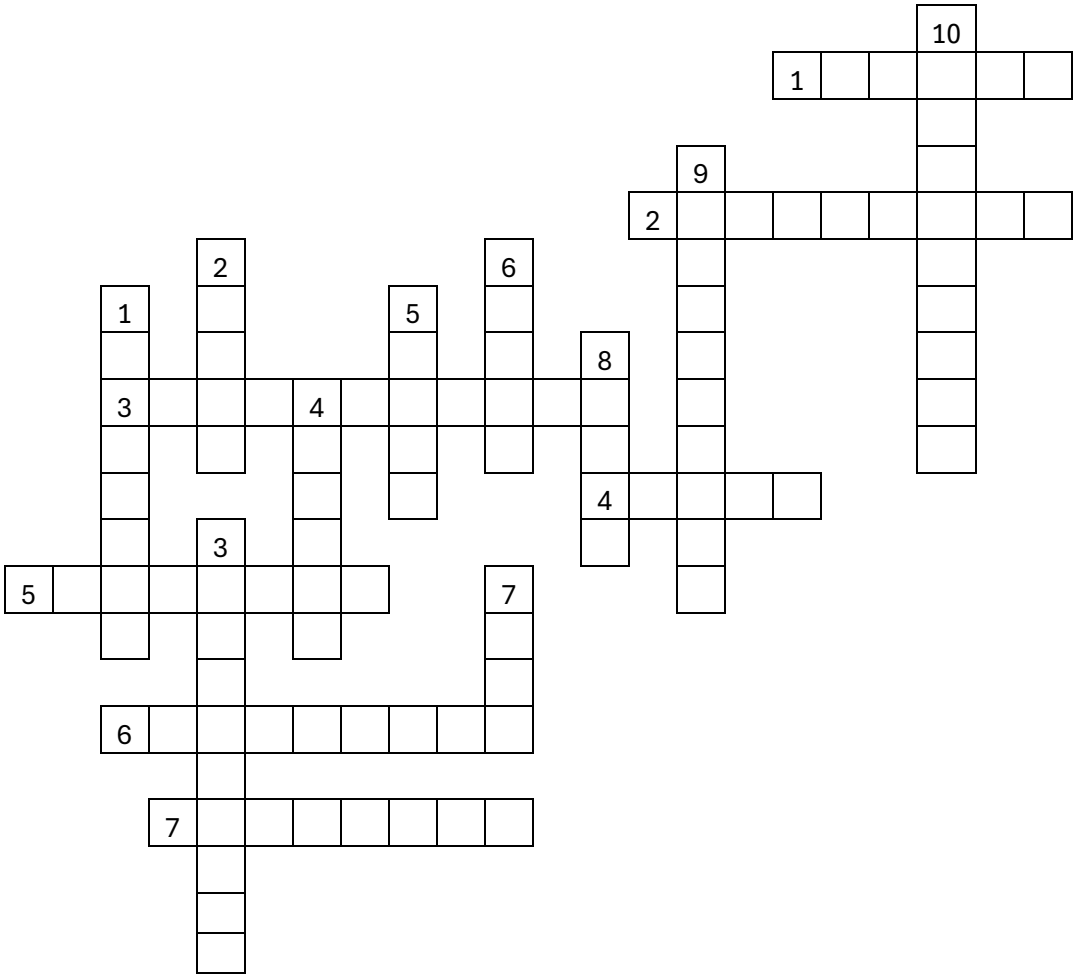
Largo
Andante
Vivace
Presto
Moderato
Prestissimo

Vastaukset:

1. Grave
2. Allegretto
3. Allegro
4. Lento
5. Vivo
6. Adagio
7. Andantino

## Appendix 4. Crossword: Musical Symbols and Terminology Made with Excel

Ristisanatehtävä: Musiikilliset merkinnät




Vaakasuunnassa (горизонтали):

Yhtäkkiä
Voimistuen
Kiihdyttäen
Erittäin, paljon
Hidastuen
Vapaan pituinen pysähdys, pidentää nuotin tai tauon kestoa
Juhlallisesti, arvokkaasti

Pystysuunnassa (по вертикали):

8. Terävästi, hyppivästi
9. Suloisesti
10. Kahden sävelen välimatka
11. Sitoen, laulavasti ja jatkuvasti
12. Voimakkaasti
13. Hiljaa
14. Kuinka kauan tämä tauko kestää  ?
15. Kuinka kauan tämä tauko kestää  ?
16. Rauhallisesti
17. Hiljentyen

Vastaukset:

1. Subito
2. Crescendo
3. Accelerando
4. Molto
5. Ritenuto
6. Fermaatti
7. Maestoso

Vastaukset:

1. Staccato
2. Dolce
3. Intervalli
4. Legato
5. Forte
6. Piano
7. Yksi
8. Kolme

9. Tranquillo
10. Diminuendo