Design and development of three original music-educational digital games for admission exams in Greek music schools

Dr. Yannis Mygdanis
Music Educator, Pierce – The American College of Greece
YMygdanis@acg.edu

Abstract
Playing is an integral part of children's daily lives in all cultures. In our current era, which is mainly digital, a vital part of children's lives involves using digital media and, consequently, digital games. Incorporating educational video games into formal or informal teaching-learning processes leads to students' interest development, motivation enhancement, as well as active participation in the lesson in a playful interactive learning environment. In this context, digital game design is critical for its effective use in the educational process, constructing rich learning environments through specific teaching objectives based on current learning theories and students' particular age and developmental characteristics. In this article, we explore three innovative digital educational musical games that were specifically designed to align with the content of admission exams at Music Schools in Greece. These engaging applications were developed by the Music Schools working project group of the Greek Society for Music Education (G.S.M.E.) as a valuable instructional resource for exam preparation. At the same time, they form conditions for integration in both the conservatoire as well as primary school music teaching-learning processes, providing creative teaching extensions.

Keywords: Educational digital game design, music education, music high schools.

1. Introduction
Play has always been an essential and universal aspect of childhood, with diverse forms of play at the heart of every culture (Ginsburg, 2007). It is widely acknowledged that play contributes significantly to children's cognitive, emotional, motor, and social growth (Zacharopoulou, 2021). In the current digital era, video games have become an integral part of the daily routine for "digital natives" (Prensky, 2001). Consequently, the integration of digital games into the educational process has become more widespread. Studies in this field have demonstrated that utilizing these games in both formal and informal teaching-learning procedures can result in heightened student engagement (Rapeepisarn et al., 2006), increased levels of participation and motivation (Habgood & Ainsworth, 2011), as well as deeper comprehension achieved through enjoyable and playful interactions within a novel learning environment (Mygdanis, 2022).

This article highlights the creation and development of three innovative digital educational musical games tailored to the content of admission exams in music high schools in Greece. These applications were designed by the Music Schools working group of the Greek Society for Music Education (G.S.M.E.) to enhance the current educational resources and provide a user-friendly educational tool that offers creative teaching extensions. The games can also be used to supplement music pedagogical activities in both conservatoire and primary school music education.

2. Educational digital games

It is widely recognized that play is an essential part of children's lives, regardless of time or culture (Zacharopoulou, 2021). In today's digital age, children's daily routines often involve the use of digital tools and games. As a result, digital educational video games have emerged as powerful tools to enhance teaching and learning processes across all levels of education (Tokarieva et al., 2019). In recent decades, video games have become incredibly popular worldwide, captivating a vast audience (Cope & Kalantzis, 2015). Digital games have firmly established themselves in contemporary digital culture as the most popular form of technology for children and everyday entertainment (Kirriemuir & McFarlane, 2004).

Digital educational games draw on the characteristics of digital games and are developed with the orientation of teaching-learning processes (Papadakis et al., 2015). These games offer a unique educational experience combining interactive gameplay and instructional content. The combination of educational content with the engaging nature of gaming has the potential to enhance learning outcomes and increase student motivation. Therefore, digital educational video games should be designed with specific teaching and learning goals in mind (de Freitas, 2006) to provide rich learning experiences that facilitate knowledge acquisition (Zacharopoulou, 2021). Moreover, digital educational games can create attractive learning environments that are distinct from traditional ones (Grigoraki et al., 2016) and contribute to the development of a new pedagogical culture in the classroom, which takes into account the interests, experiences, desires, and needs of students (Mygdanis, 2022; Papadakis et al., 2015). Additionally, digital educational video games can be an effective tool for formative assessment by providing immediate feedback to students, allowing them to track their progress and identify areas for improvement (Valentová & Brečka, 2023).

Research demonstrates the assistance of digital games –educational or not– as a learning tool at all levels of education (Papadakis et al., 2015). Their integration in formal or informal environments leads to greater effectiveness in learning processes (Zacharopoulou, 2021) through playful interaction and increased student interest (Chou, 2019; Rapeepisarn et al., 2006). At the same time, motivation is developed for active participation (Walz & Deterding, 2014; Habgood & Ainsworth, 2011; Paras & Bizzocchi, 2005), while students can proceed at their own pace and gain self-regulation (Sumuer & Yakin, 2009).

2.1. Design and development of digital educational games

The proper design of digital educational games plays a crucial role in their effective use within the educational process (Zacharopoulou, 2021; Papadakis et al., 2015). With a broader outlook incorporating play elements as an activity, the goal is to create immersive learning environments that align with current learning theories, age-specific characteristics, and students' developmental criteria. Achieving this balance between the digital and real world is critical to meeting specific teaching-learning objectives (Zacharopoulou, 2021; Mygdanis et al., 2019; Miller & Kocurek, 2017).

Multiple studies and researchers have explored the potential of educational video games, emphasizing the need for well-designed games that promote learning, and a literature review in the field agrees that an educational video game's design should meet specific development axes. Although there has yet to be a consensus on the design element (Frazer et al., 2007), in a broader context, construction should be based on fun, enjoyment, and entertainment through a playful form for individual active participation (Prensky, 2001). A

fundamental element is representing a story with a specific structure in an attractive environment, creating challenges with predetermined rules for problem-solving through competition and interaction (Frazer et al., 2007; Paras & Bizzocchi, 2005). In addition, solving challenges and problems should form conditions for cultivating students' motivation and creativity (Cojocariu & Boghian, 2014; Prensky, 2001). Simultaneously, an educational game should be flexible to adapt to the specific needs of a classroom (Miller & Kocurek, 2017) as well as support forms of assessment as an integral part of the learning process (Cojocariu & Boghian, 2014; Prensky, 2001). All in all, these games should provide appropriate and adaptive feedback, stimulate strategic thinking and creativity, and embed cognitive strategies to enhance student learning (Mygdanis, 2022).

Digital educational games can be categorized into mini-games and complex games (Prensky, 2005). Mini-games are uncomplicated learning objects that usually focus on a monothematic story. They are typically developed by teachers to enrich their educational process, and the duration of engagement required by the student is less than an hour (Frazer et al., 2007; Prensky, 2005). In contrast, complex games are more challenging, involve different story scenarios, and focus on different skills at each level. They are developed by educational game design companies and usually require tens of hours of involvement to complete the story's plot (Prensky, 2005).

Recent research has revealed that digital games, including mini-games, offer numerous benefits for education. They promote active participation, experimentation, and exploration, enabling students to learn through practical experience. Additionally, mini-games within digital educational video games provide opportunities for personalized learning, as they offer varying difficulty levels that can cater to students of different learning abilities (Chen et al., 2020). Furthermore, mini-games can help cultivate critical thinking, problem-solving, and decision-making skills in students. Moreover, mini-games within digital educational video games promote collaboration and competition among students, encouraging teamwork and social interaction as they play together or compete against each other to achieve the highest scores or complete objectives (Valentová & Brečka, 2023; Quinto, 2022).

In conclusion, creating an educational video game requires a delicate balance between informative content and captivating gameplay. It is essential to harmonize the learning objectives with the entertaining features of the game to keep players motivated and engaged while also facilitating their acquisition of new knowledge and skills.

3. Admission Exams to Greek Music High Schools

The admission exams of future students in Music Schools in Greece consist of four independent modules –A. Rhythm perception, B. Aural skills, C. Vocal and singing skills, and D. Distinction of musical phrases, sounds, and timbre.[30] Each one includes tests that are suggested and presented as “musical games.” The following is an indicative excerpt from the exam specifications:

> Future students [...] are required to respond to four musical games. In the first game, they must recognize how many times a particular melodic phrase is repeated in the piece and state the number in the corresponding box of the first game. In the second game, they must mention the number of musical instruments heard in the specific

[30] The procedure is defined by 58167/D2/13-04-2018 “Operation of Music Schools” (Β΄ 1371) and Official Gazette B' 1574 / 08-05-2018.

musical passage in the corresponding box. In the third game, they are asked to identify and name the category in which the musical instruments are heard from the CD. In the fourth game, the students must correct matching music tracks with given titles.

The above passage makes it apparent that the term “musical games” raises concerns. A concise story with rules and structure is not identified, nor is an attractive environment constructed. These tests are multiple-choice, complementary, or matching exercises with no playful elements. This fact leads to the determination, as the research in the field has argued that gamification without a proper “wrapper” is limited to a simple behavioral approach (Zeipekis & Theofanellis, 2015).

4. Development of the Three Original Educational Games

This section delves into the development and design principles of three educational music video games. These games were created by the Greek Society for Music Education (G.S.M.E.) teamwork group, which focuses on ensuring the proper functioning of Music Schools in Greece.[31] The development process and workgroup were overseen by Dr. Anthoula Koliadi-Tiliakou. The first introduction of these games happened on June 12, 2021, during an online conference called "Music Schools, let us begin!" that was aimed at aspiring students and music teachers.

The construction of the applications was established on reaching specific teaching goals, as defined by the admission exams to the first-year class of Music High School. The design was oriented to the development principles of digital educational games, drawing on gamification principles (Chou, 2019). All three applications consist of mini-oriented games, demanding less than an hour for engagement by the students to complete the overall game scenario. Each one depicts a specific challenge with structured rules, which the student has to find the solution. Through each resolution, rewards are given – points, prizes, bonuses– and difficulty levels increase at every stage. In this way, the games provide continuous and valuable feedback in an informal way as a form of assessment for the learning process (Prensky, 2005). With an emphasis on development, the educational material utilizes current Web 2.0 and multimedia technologies. All games operate in every web browser, independently of the operating system (Papadakis et al., 2015).

Although the design orientation was carried out to enhance the teaching material for the Music Schools examinations, prerequisites for usage and integration in multiple music-educational activities applied in different musical learning contexts –general music school education, conservatoire settings– are emerging. Considering current digital music environments (Kokkidou, 2016), experiential teaching approaches –interdisciplinarity, multimodality–elements of inquiry, game-based learning, and collaborative practices give meaning to teachers and students, the use of educational digital material presents pedagogical added value to music teaching-learning (Zacharopoulou, 2021).

The design's ultimate goal was to develop tools for use in various learning environments, for actions with creative teaching perspectives depending on students' level and developmental criteria, and to meet specific teaching and learning objectives (Miller & Kocurek, 2017; Ally, 2004). In addition to the admission exams to the Music Schools, they can

[31] The three original digital educational music games are available on the Greek Society for Music Education website at https://www.eeme.gr/musapps.html.

be combined with the syllabus of the conservatoire education (Mygdanis & Kokkidou, 2018) but also be associated with the teaching objectives of the general music school curriculum called “New School” –School of the 21st century– (Mygdanis et al., 2019), emphasizing active listening activities, through playful and interactive students' participation. Overall, these digital games can be partially or independently integrated into music-pedagogical actions in the classroom or distance music education, adapted to specific teaching-learning conditions and activities outside educational institutions.

4.1. Space Music Glockenspiel

The digital educational game Space Music Glockenspiel was based on the part of the exams called “Aural skills,” emphasizing the phrase “the examiner plays a melodic motive ranging up to five notes on the piano, and the candidate has to memorize and perform it on the glockenspiel.”

Figure 1. Space Music Glockenspiel

The story draws on a space theme. The spaceship of the music alien crashes on an unknown planet, and the five robots he had with him lose their direction. The alien invites the student to assist him in finding their robots, the only ones that can repair the spaceship and return to their planet. The robots can only recognize the music alien's melodies and return back. The student listens to the melody and has to repeat it on the virtual glockenspiel –using the mouse, keyboard, or his finger on a touch screen. As the attempts increase, the melodies become more and more complicated. The student has a total of 30 attempts to help the alien before the robots are lost in space forever.

All melodies consist of five notes. Each one is played twice, and then the original note flashes twice on the glockenspiel. Depending on the percentage of correct guessed notes, the user earns specific points (1 point for three correct notes, 1.5 points for four, and 2 points for five). There is an opportunity for the student to listen to the melody again. However, there is a penalty of 0.25 points for each repetition. There is also the option to try a note again, with a penalty of 0.10 points for each attempt. A robot appears at every 5 points the student earns, and the melodies become more complex. In the beginning, melodies consist of notes at a melodic major third interval. Gradually, motives are constructed from intervals of 4th, 5th, 6th, and, at the last level, of an octave.

4.2. Deep Blue Music Bottom

The second digital educational game, Deep Blue Music Bottom, also draws from the "Aural skills" section, emphasizing the state: "The candidate hears randomly selected notes on the piano and has to identify the tonal change in pitch and show it by moving his hand up or down."

The game's story occurs on a deep music bottom, where a jellyfish attacks six small fish. The only one who can help them prevent the attack is a pufferfish. However, saving small fish and averting the jellyfish is challenging. The jellyfish becomes invisible and can be perceptible only by the sound of its movement -up or down. The student ought to move the pufferfish to the point where he considers the jellyfish hiding in order to stand in front and stop it. The jellyfish eats from one of the small fishes at every wrong pufferfish movement. All in all, there will be 30 attacks. If it has not achieved eating all six fishes, it will travel to another deep bottom.

Figure 2. Deep Blue Music Bottom

The process of attacking is an interpretation of the musical elevator game (the student moves his hand up and down depending on the pitch). In the beginning, the jellyfish stands in the center of the screen, indicating the middle-C position (C4). When it becomes invisible, a melodic interval varying from notes E3 to A4 is heard twice. The melodic interval represents the hidden movement of the jellyfish. In the subsequent attempts, the fundamental note of the interval is the last note of the previous attempt. In this way, the jellyfish move smoothly - up or down- in a randomly selected range between E3 and A4. In other words, each new attack starts from the jellyfish's last position, providing a continuous attacking movement. With the mouse or the finger on a touch screen, the student picks a position that he considers the jellyfish is hiding, forming the melodic interval - ascending, descending, or unison.

4.3. The Rhythm of Apache

The educational musical game The Rhythm of Apache was designed based on the "Rhythm Perception" activity where "the examiner claps a rhythmic pattern, and the goal is for the student to respond and determine whether he perceives rudimentary rhythmic structures."

As for the plot, the student desires to become a member of the Apache tribe. To be accepted, he must first learn secret elements of their culture, which are revealed when one can perform the rhythms of their dances. Each time the student plays the rhythm accurately

on the virtual drum, he earns points. There are no limits on the number of attempts. Some hidden 'treasures' for Native American tribes emerge every seven points a part of culture appears. Every level provides more complex rhythmic patterns. In the eleven levels, the whole village will appear to the student. When the student passes the last one (twelve), he is accepted as a new member of the Apache tribe.

Figure 3. The Rhythm of Apache

Each rhythmic motive is heard twice and contains a range of two musical bars. The percussion instrument flashes and the child is requested to repeat the pattern with the mouse click, the Space key, or the finger on a touch screen. For a stable performance, a background metronome is heard. The student earns from 1 to 3.5 points depending on the success rate. The first level's rhythmic patterns consist of half notes, quarters, and eighths, along with their corresponding pauses. Gradually, additional rhythmic patterns are added. The application contains a total of 13 distinct rhythmic patterns. At the same time, the time signature alternates between 2/4 and 3/4. At the last level, it changes to 4/4.

5. Conclusion and future perspectives

The new digital educational games contribute to the expanding educational material that students can use to prepare for the admission exams to Music High Schools in Greece. In addition, they are new instructional tools that primary music school and conservatoire teachers can integrate into their educational process, enriching the music teaching-learning processes with elements of playfulness and gamification.

Undoubtedly, there is always room for improvement and growth when it comes to incorporating gaming design principles (Chou, 2019) and developing educational digital games (Prensky, 2001) into teaching practices. One of the immediate future goals is to expand story scenarios to include more interactive features with multi-user support. Additionally, providing teachers and students with the ability to adjust the difficulty level would create greater flexibility and allow for more efficient adaptation to the unique conditions of a music class. To effectively implement these changes in the classroom, it's crucial to evaluate and assess current digital games from the perspective of music teachers. By developing educational interventions in various learning environments, we can gain new insights into integrating digital games in music lessons (Zacharopoulou, 2021). Through this process, we may also uncover issues related to the specific needs and desires of teachers and students, as well as the limitations of certain digital educational objects and proposals.

In conclusion, a broad view of the whole project is the development of new digital educational music games for the entire content of the admission exams to Music High Schools. The design will focus on the interconnection of all digital educational constructions to form a complete digital instructional material within a single structure. In this, it is crucial to consider factors that will contribute to the involvement of students in creative activities through more vital social interaction between teachers and students, drawing on current digital and multimodal learning music environments.

Bibliographic References

Ally, M. (2004). Designing effective learning objects. In R. McGreal (Ed.), *Online Education using learning objects* (pp. 87–97). Routledge.

Chen, C. Y., Huang, H. J., Lien, C. J., & Lu, Y. L. (2020). Effects of multi-genre digital game-based instruction on students' conceptual understanding, argumentation skills, and learning experiences. *IEEE Access*, *8*, 110643-110655.

Chou, Y. K. (2019). *Actionable Gamification: Beyond points, badges, and leaderboards* (2nd Ed.). Octalysis Media.

Cojocariu, V. M. & Boghian, I. (2014). Teaching the relevance of game-based learning to preschool and primary teachers. *Procedia-Social and Behavioral Sciences*, *142*, 640-646.

Cope, B., & Kalantzis, M. (2015). Sources of evidence-of-learning: Learning and assessment in the era of big data. *Open Review of Educational Research*, *2*(1), 194-217.

de Freitas, S. (2006). *Learning in Immersive worlds: A review of game-based learning*. Joint Information Systems Committee.

Frazer, A., Argles, D., & Wills, G. (2007). Is less actually more? The usefulness of educational mini-games. In *Seventh IEEE International Conference on Advanced Learning Technologies* (pp. 533-537). IEEE.

Ginsburg, K. R. (2007). The importance of play in promoting healthy child development and maintaining strong parent-child bonds", *Paediatrics*, *119*(1), 182–191.

Grigoraki, M., Peraki, F., & Politi, A. (2016). Evaluation of educational software about its learning effectiveness: the case of the online game GREPOLIS and its pedagogical integration history lessons in the elementary school [in Greek]. In A. Lionarakis (Ed.) *Proceedings of the 7th Conference on Open & Distance Education - Volume 6B* (pp. 55-64).

Habgood, M. J., & Ainsworth, S. E. (2011). Motivating children to learn effectively: Exploring the value of intrinsic integration in educational games. *The Journal of the Learning Sciences*, *20*(2), 169–206.

Kirriemuir, J., & McFarlane, E. (2004). *Literature review in games and learning*. Nesta Futurelab series.

Kokkidou, M. (2016). Musical literacy in the aftermath of postmodernism: from ignorance to consciousness [in Greek]. In M. Kokkidou & Z. Dionysiou (Eds.), *Music Literacy: Typical and Informal Forms of Music Teaching-Learning* (pp. 3–36). G.S.M.E.

Miller, J. L. & Kocurek, C. A. (2017). Principles for educational game development for young children. *Journal of Children and Media*, *11*(3), 314-329.

Mygdanis, Y. (2022). Design and develop three prototype digital music games for future music high school students [in Greek]. In *Proceedings of the Panhellenic Conference "The educational game and arts in education and culture"* (pp. 184–192). EKEDISY.

Mygdanis, Y. & Kokkidou, M. (2018). The 'Theory of Music' course in conservatoire education: a first overview of the field and assessment of current reality [in Greek]. *Mousikopedagogika*, *16*, 28-48.

Mygdanis, Y., Kondylidou, A., & Kokkidou, M. (2019). Social Values and Music Curricula: Comparative research [in Greek]. In Th. Raptis & D. Koniari (Ed.), *Music Education and Society: new challenges, new orientations. Proceedings of the 8th Conference of G.S.M.E.* (pp. 280–289).

Papadakis, S., Orfanakis, V., & Kalogiannakis, M. (2015). Digital games at the service of the educational process [in Greek]. In *Proceedings of the 1st Panhellenic Conference - The modern school through the prism of the humanities and social sciences: From theory to daily practice*. I.A.K.E.

Paras, B., Bizzocchi, J. (2005). Game, Motivation, and Effective Learning: An Integrated Model for Educational Game Design. In *Proceedings of the DiGRA 2005 Conference: Changing Views - Worlds in Play*.

Prensky, M. (2001). Fun, play and games: What makes games engaging. *Digital game-based learning*, *5*(1), 5–31.

Prensky, M. (2005). Complexity Matters, *Educational Technology*, *45*(4), 1–15.

Quinto, J. (2022). Development and Validation of Survey Instrument on Game-Based Learning Approach. *International Journal of Emerging Technologies in Learning, 17*(15), 233-242.

Rapeepisarn, K., Wong, W., Fung, C. & Depickere, A. (2006). Similarities and differences between 'learn through play' and 'edutainment. In *Proceedings of the 3rd Australasian Conference on Interactive Entertainment* (pp. 28–32). Murdoch University.

Sumuer, E. & Yakin, I. (2009). Effects of an educational game development course on preservice teachers' concerns about the use of computer games in the classroom. In *Proceedings of the 9th International Educational Technology Conference* (pp. 22-27). Hacettepe University.

Tokarieva, A. V., Volkova, N. P., & Harkusha, I. V. (2019). Educational digital games: models and implementation. *Educational Dimension*, *1*(53), 5–26.

Valentová, M., & Brečka, P. (2023). Assessment of Digital Games in Technology Education. *International Journal of Engineering Pedagogy*, *13*(2).

Walz, S. P., & Deterding, S. (2014). *The gameful world: Approaches, issues, applications*, M.I.T. Press.

Zacharopoulou, K. (2021). Creation of Digital Educational Games for the Music lesson in preschool and primary education [in Greek]. In *Proceedings of the 1st Panhellenic Conference - The educational game in formal and non-formal learning* (pp. 306–315). E.K.E.D.I.S.Y.

Zeipekis, A. & Theofanellis, T. (2015). Playfulness of the didactic act. *Educational Sciences*, *1*, 96-109.