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Algorithms for rapid memorization of musical notation through associative thinking in the methodology of early music education

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Abstract. The relevance *of the study is determined by the necessity to improve the effectiveness of early music education under conditions of increasing demands on the speed of musical notation acquisition, the development of musical memory, and the formation of stable performance skills in primary school children. In contemporary pedagogical practice, mechanical repetition of notation material is becoming increasingly insufficient, which actualizes the need for methods aimed at activating figurative, emotional, and multisensory perception of music. Particular significance is attached to associative thinking as a tool for forming stable cognitive connections between sound, rhythm, movement, emotional imagery, and notation symbols.* ***The purpose*** *of the article is defined as the development and theoretical-methodological substantiation of approaches to the use of associative thinking for accelerating the memorization of musical notation within the system of early music*

education. ***Methods.*** *The study employed methods of theoretical generalization, analysis and synthesis of scientific sources, a logical-analytical approach, and the method of pedagogical interpretation to identify the functional capabilities of associative algorithms in music education.* ***Results.*** *The pedagogical significance of associative thinking in the formation of beginner learners' musical memory has been investigated. It has been revealed that the combination of visual, auditory, emotional, and motor associations increases the stability of memorization of musical material and improves the quality of its reproduction. Methodological approaches to integrating associative algorithms into the structure of early music education have been substantiated, particularly through rhythmic-motor synchronization, visual-structural modeling, and contextual interpretation of musical text. Key scientific and practical problems have been identified, including insufficient systematization of associative methods, cognitive overload of learners, instability of concentration, and limited adaptation of methods to the individual perceptual characteristics of children.* ***Conclusions.*** *It has been proven that the effectiveness of memorizing musical notation significantly increases through the combination of multisensory interaction, emotional engagement, and consistent organization of associative learning. Prospects for further research are associated with the development of adaptive music education models for different age groups, empirical verification of the effectiveness of associative algorithms, and investigation of the potential of digital interactive technologies in the development of musical memory.*

Keywords: *musical memory, primary arts education, rhythmic-motor coordination, figurative perception, performance stability, cognitive adaptation, sensory interaction, interpretative thinking.*

PEDAGOGICAL ACADEMY:
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Алгоритми швидкого запам'ятовування нотного тексту через асоціативне мислення в методиці раннього музичного навчання

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Анотація: ***Актуальність дослідження*** *зумовлена необхідністю підвищення ефективності раннього музичного навчання в умовах зростання вимог до швидкості засвоєння нотного тексту, розвитку музичної пам'яті та формування стійких виконавських навичок у дітей початкового віку. У сучасній педагогічній практиці механічне повторення нотного матеріалу дедалі частіше виявляється недостатньо результативним, що актуалізує потребу у впровадженні методик, орієнтованих на активізацію образного, емоційного та multisensory сприйняття музики. Особливої значущості набуває використання асоціативного мислення як інструменту формування стійких когнітивних зв'язків між звуком, ритмом, рухом, емоційними образами та нотними символами.* ***Метою статті*** *визначено розроблення й теоретико-методичне обґрунтування підходів до використання асоціативного мислення для прискорення процесів запам'ятовування нотного тексту в системі ранньої музичної освіти.* ***Методи.*** *У процесі дослідження використано методи теоретичного узагальнення, аналізу та синтезу наукових джерел, логіко-аналітичний підхід, а також метод педагогічної інтерпретації для виявлення функціональних можливостей асоціативних алгоритмів у музичному навчанні.* ***Результати.*** *Досліджено педагогічне*

значення асоціативного мислення у формуванні музичної пам'яті початківців. Виявлено, що поєднання візуальних, слухових, емоційних і моторних асоціацій підвищує стійкість запам'ятовування музичного матеріалу та покращує якість його відтворення. Обґрунтовано методичні підходи до інтеграції асоціативних алгоритмів у структуру раннього музичного навчання, зокрема через ритмічно-рухову синхронізацію, візуально-структурне моделювання та контекстну інтерпретацію музичного тексту. Виявлено ключові наукові та практичні проблеми, серед яких недостатня систематизація асоціативних методик, когнітивне перевантаження учнів, нестійкість концентрації уваги та обмежена адаптація методів до індивідуальних особливостей сприйняття дітей. ***Висновки****. Доведено, що ефективність запам'ятовування нотного тексту суттєво зростає за умови поєднання мультисенсорного сприйняття, емоційної залученості та послідовної організації асоціативного навчання. Перспективи подальших досліджень пов'язані з розробленням адаптивних моделей музичного навчання для різних вікових груп, емпіричною перевіркою ефективності асоціативних алгоритмів та дослідженням можливостей цифрових інтерактивних технологій у розвитку музичної пам'яті.*

Ключові слова: *музична пам'ять, початкова мистецька освіта, ритмічно-рухова координація, образне сприйняття, виконавська стійкість, когнітивна адаптація, сенсорна взаємодія, інтерпретаційне мислення.*

Problem statement. The effectiveness of early music education largely depends on the child's ability to perceive, structurally organize, and retain musical material within a limited period of study. In practical piano and solfeggio training, teachers increasingly face difficulties related to unstable memorization of notation, rapid loss of attention, and mechanical reproduction of musical material without meaningful comprehension. Such tendencies reduce the quality of performance

skills and complicate the development of artistic thinking at the initial stage of musical formation. In this context, particular importance is attributed to pedagogical approaches that activate figurative perception, emotional associations, and multisensory interaction during work with musical text. The use of associative thinking creates conditions for strengthening cognitive connections between sound, image, movement, rhythm, and visual symbols, which positively influences the speed and durability of memorization. At the same time, methodological support for the practical application of such approaches in beginner music training remains fragmented and insufficiently systematized, especially regarding the sequence of pedagogical actions, age adaptation of associative techniques, and their integration into contemporary models of early artistic education.

Analysis of recent research and publications. A review of contemporary research demonstrates the multidimensional nature of scientific approaches to the problem of rapid memorization of musical notation through associative thinking within the methodology of early music education. Y. Pinchuk analyzes the career strategies of opera singers in European and American cultural institutions, emphasizing the importance of professional musical training, stage memory, and the ability of performers to quickly master musical material in various educational and cultural environments [1]. I. Taran examines the pedagogical properties of musical memory, highlighting its role in the perception and retention of musical information, which forms an important theoretical basis for the development of associative memorization algorithms for musical notation at the initial stage of music education [2]. T. Dorosh and I. Tatarko investigate the development of musical memory in future music teachers during the study of piano works, emphasizing the significance of systematic repetition, emotional perception, and interpretative understanding of musical texts [3]. W. Hibi substantiates the relationship between music education, mathematical skills, and cognitive development, allowing musical notation to be considered as a structured symbolic system whose memorization can be

strengthened through logical, rhythmic, and visual associations [4]. B. Tanriguden proposes a cognitive load theory-based method for teaching western standard music notation, demonstrating that excessive informational complexity may negatively affect the speed and effectiveness of memorizing musical texts in early music learning [5].

T. Chen analyzes the effectiveness of the WeChat social media platform in classical music education in China and its influence on the communicative and cognitive skills of music students, thereby expanding the understanding of digital environments as supportive tools for repetition and memorization of musical material [6]. E. de la Mora Velasco and M. Moreno explore new perspectives and directions in online music learning, emphasizing the transformation of pedagogical interaction, methods of presenting musical information, and the role of digital technologies in knowledge acquisition [7]. R. K. Chaturvedi and N. A. Shelke investigate music generation using a hybrid deep neural model, which, although primarily technological in orientation, demonstrates algorithmic principles of musical structure that may be methodologically useful for modeling sequential memorization of musical notation [8]. E. de la Mora Velasco and co-authors, in a systematic review and meta-analysis, examine the impact of background music on learners, highlighting conditions under which musical environments may either facilitate or overload cognitive and mnemonic processes [9]. H. Aditya and co-authors analyze music generation through recurrent neural networks and long short-term memory models, demonstrating the significance of repetitive musical patterns and structural sequences that can serve as a foundation for associative memorization techniques [10].

V. Vuong and co-authors investigate the electrophysiological correlates of autobiographically salient music listening, proving the close relationship between melody, memory, and personal associations in cognitive processes [11]. S. Schaerlaeken, D. Glowinski, and D. Grandjean examine the relationship between

musical metaphors and emotions evoked by classical music, which is particularly important for understanding the formation of emotional and imaginative associations during the memorization of musical notation [12]. L. Wei and co-authors review the development and application of artificial intelligence in music generation, emphasizing the transformation of digital systems from supportive tools into creative environments, which opens prospects for adaptive educational exercises in music literacy [13]. M. Mansoori and R. Murali systematize approaches to music composition using artificial intelligence, deepening the understanding of algorithmic organization of musical structures and their pedagogical potential [14]. J. Liang analyzes the transformative power of machine learning in music, focusing on the integration of musical regularities with computational models, which may contribute to the development of intelligent systems for supporting early music education [15]. Therefore, existing studies provide a substantial theoretical and methodological basis for understanding musical memory, associative perception, cognitive load, emotional interpretation, and digital technologies in music learning. However, the issue of developing comprehensive algorithms for rapid memorization of musical notation through associative thinking specifically within the methodology of early music education still requires further scientific substantiation and pedagogical elaboration.

Identification of previously unresolved parts of the general problem. Despite the growing use of associative methods in music pedagogy, the mechanisms through which associative thinking influences the stability and speed of memorization of musical notation in beginner learners remain insufficiently clarified. Existing studies mainly focus on separate aspects of musical memory or emotional perception, while multisensory interaction and methodological integration of associative techniques into early music education are considered fragmentarily.

The unresolved nature of these issues limits the effectiveness of beginner music training and preserves the dominance of mechanical memorization practices that often reduce concentration, interpretative awareness, and performance stability. This determines the necessity of further research aimed at substantiating structured pedagogical approaches capable of improving the quality and continuity of memorization processes in early music education.

Formulation of the objectives of the article (task setting). The purpose of the article is to develop and substantiate methodological approaches to the use of associative thinking for accelerating the memorization of musical notation in the process of early music education.

Objectives of the article:

1. To determine the pedagogical role of associative thinking in the memorization of musical notation by beginner learners.
2. To substantiate methodological approaches and identify the key problems of integrating associative memorization techniques into early music education.
3. To develop recommendations for improving methods of accelerated memorization of musical notation in beginner music training.

Main material. Associative thinking occupies an important place in early music education because it strengthens the interaction between sensory perception, emotional response, and symbolic understanding of musical notation. At the beginner stage, memorization becomes more effective when musical material is connected with images, movement, rhythmical patterns, or emotionally meaningful comparisons. Such pedagogical interaction promotes not only faster retention of notation, but also the formation of stable auditory and interpretative skills necessary for further musical development (table 1).

Table 1

Pedagogical significance of associative thinking in the processes of perception and memorization of musical notation at the initial stage of music education

Component	Substantive characteristic	Manifestation in beginner music education	Pedagogical significance
Cognitive	Formation of stable connections between symbolic and figurative perception	Recognition of notes through visual and imaginative associations	Accelerates orientation in musical notation
Emotional	Involvement of emotional memory in educational interaction	Association of melodies with emotions, characters, or stories	Strengthens durability of memorization
Auditory	Integration of sound perception with associative imagery	Correlation of pitch and rhythm with familiar auditory patterns	Improves auditory recognition of musical structures
Motor	Combination of movement and tactile interaction with memorization processes	Finger movement associations and rhythmic gestures during performance	Enhances coordination and memorization stability
Creative	Activation of imaginative interpretation of musical material	Creation of individual associative images for musical phrases	Stimulates artistic perception and learner engagement

Source: developed by the author based on [2, p. 235; 3, p. 147; 4, p. 186; 5, p. 18; 12, p. 251].

Children of early school age usually memorize musical material more confidently when notation is connected with familiar sensory experience rather than explained exclusively through theoretical terminology. For this reason, music teachers increasingly rely on figurative parallels that simplify the perception of rhythm, pitch movement, intervals, and phrase structure. A melodic line may be perceived as movement through space, repeated rhythmic figures as familiar everyday actions, while contrasting dynamics are often explained through emotional states or changes in character behavior [2, p. 235]. Such associations create additional cognitive reference points that help learners restore musical sequences more naturally during performance.

Noticeable results can also be observed in the development of performance confidence. When memorization is supported by emotional and visual imagery, children demonstrate less fear of mistakes and retain musical continuity more effectively during public performance or lesson repetition. Associative interaction additionally strengthens concentration because attention shifts from monotonous repetition toward imaginative interpretation of musical material. In contemporary educational practice, these approaches are often combined with movement exercises, rhythmic imitation, graphic visualization of phrases, and interactive digital resources that synchronize auditory and visual perception [12, p. 251]. Under such conditions, memorization develops not through mechanical accumulation of information, but through the formation of interconnected sensory and emotional structures that significantly improve the quality of early musical learning.

The stability of musical memory in beginner learners is determined not only by the frequency of repetition, but also by the depth of multisensory perception involved in the learning process. At the initial stage of music education, the simultaneous activation of visual, auditory, emotional, and motor channels significantly increases the durability of memorized musical material and improves the accuracy of its reproduction. The interaction of several perceptual mechanisms enables children to form stronger internal connections between sound, movement, rhythm, imagery, and notation structure, which facilitates quicker recall and more confident performance activity (table 2).

Table 2

Influence of multisensory associations on the formation of stable musical memory in beginner learners

Type of association	Functional influence on memorization	Manifestation during educational interaction	Result for musical memory formation
Visual	Strengthening symbolic recognition through imagery and spatial perception	Use of color coding, graphic schemes, visual comparison of melodic movement	Faster restoration of notation sequences

Auditory	Formation of stable sound-based memory patterns	Repetition through listening, vocal imitation, recognition of tonal contrasts	More accurate retention of pitch and rhythm structures
Emotional	Reinforcement of memorization through emotional involvement	Connection of musical fragments with moods, stories, or expressive characters	Increased durability of long-term memorization
Motor	Consolidation of memory through coordinated physical activity	Rhythmic gestures, tactile keyboard orientation, coordinated finger movement	Stabilization of performance accuracy
Integrated multisensory interaction	Synchronization of several perceptual channels during learning	Simultaneous combination of listening, movement, visualization, and emotional response	Formation of complex and stable musical memory mechanisms

Source: developed by the author based on [2, p. 236; 3, p. 148; 9, p. 1604; 11, p. 9; 12, p. 257].

The interaction of visual, auditory, emotional, and motor associations significantly increases the stability of musical memory because memorization occurs through several interconnected perceptual mechanisms simultaneously. In beginner instruction, this is especially important when children experience difficulties maintaining continuity of rhythm, melodic direction, or coordinated performance after short periods without repetition [11, p. 9]. Multisensory associations reduce fragmentation of memorization since each perceptual channel supports the restoration of musical material during recall.

Visual associations are frequently strengthened through graphical segmentation of phrases, color differentiation of rhythmic structures, and spatial representation of melodic movement. Such approaches help learners recognize internal logic within notation rather than memorize isolated symbols mechanically. Auditory associations contribute to the development of internal hearing through repeated listening, vocal imitation, and anticipation of tonal movement, allowing children to reproduce melodic structures more confidently [11, p. 9]. Motor interaction also plays a stabilizing role because coordinated finger movement,

rhythmic gestures, and tactile orientation on the keyboard gradually form procedural memory that supports accurate performance.

Emotional associations intensify long-term retention because musical fragments connected with vivid imagery or expressive situations are reproduced more naturally and with greater concentration. In contemporary music pedagogy, these mechanisms are often combined with interactive digital visualization, animated rhythm exercises, and synchronized audiovisual tasks that simultaneously activate several sensory channels. As a result, memorization becomes faster, more conscious, and less dependent on mechanical repetition of notation material.

The integration of associative memorization algorithms into early music training requires coordinated methodological interaction between perception, repetition, and interpretative comprehension of musical material. In beginner education, associative techniques demonstrate the highest effectiveness when they are systematically embedded into lesson structure and adapted to the cognitive and emotional characteristics of young learners. Such approaches strengthen the continuity of memorization and improve the stability of musical reproduction during performance activity (table 3).

Table 3

Methodological approaches to the integration of associative memorization algorithms into early music training

Methodological approach	Educational focus	Mechanism of implementation	Expected pedagogical effect
Sequential associative reinforcement	Gradual consolidation of memorized material	Step-by-step introduction of imagery, rhythmical, and movement associations	Formation of stable memorization patterns
Contextual interpretation	Connection of notation with meaningful artistic context	Use of stories, characters, and emotional situations during learning	Improvement of interpretative comprehension
Rhythmic-motor synchronization	Coordination of perception and physical response	Integration of gestures, body movement, and tempo exercises	Stabilization of rhythmic accuracy

Visual-structural modeling	Development of structural understanding of musical text	Graphic representation of phrases and melodic architecture	Faster orientation within notation patterns
Adaptive multisensory interaction	Adjustment of associative methods to individual learner perception	Combination of auditory, tactile, visual, and emotional stimuli according to learner needs	Increased flexibility and effectiveness of memorization

Source: developed by the author based on [4, p. 190; 5, p. 21; 6, p. 17475; 7, p. 2576; 15].

The methodological value of associative algorithms becomes particularly evident when memorization is organized as a sequential cognitive process rather than reduced to repetitive mechanical practice. In contemporary beginner instruction, teachers frequently divide musical material into structurally connected segments that are reinforced through different associative channels at each stage of learning. For example, the first presentation of a phrase may rely on auditory imitation and emotional imagery, while subsequent work integrates rhythmic gestures, spatial orientation on the keyboard, and visual recognition of melodic contour [4, p. 190]. Such sequencing creates layered memorization mechanisms that significantly improve continuity of performance.

Contextual interpretation also changes the quality of learner interaction with notation. Musical fragments associated with narrative situations, movement characteristics, or expressive contrasts are reproduced with greater concentration because the child memorizes not only symbolic information, but also the internal artistic logic of the passage. In piano pedagogy, ascending melodic motion is often connected with gradual physical movement across the keyboard, whereas articulation contrasts may be explained through comparisons with speech patterns, jumping motion, or flowing movement [7, p. 2576]. These methods simplify perception of abstract notation structures without reducing musical complexity.

An important methodological effect is observed in the stabilization of rhythm and coordination. Rhythmic-motor synchronization techniques, including body

percussion, coordinated gestures, and tempo imitation, help learners internalize pulse organization before technical execution becomes fully automated. At the same time, adaptive multisensory interaction allows teachers to modify memorization strategies according to dominant learner perception [5, p. 21]. Some children demonstrate higher retention through visual phrase architecture, while others rely more strongly on auditory anticipation or tactile repetition. Such flexibility increases memorization efficiency and reduces cognitive overload, particularly during the early stages of instrumental preparation where attention stability and symbolic abstraction remain insufficiently developed.

The effective use of associative techniques in the memorization of musical text by beginner musicians is complicated by a range of methodological, cognitive, and organizational problems that reduce the stability of musical memory and the quality of performance reproduction. One of the main difficulties lies in the insufficient systematization of associative approaches within early music education, since many teachers apply such techniques intuitively without clear methodological sequencing [15]. As a result, associative memorization often remains episodic and fails to form stable cognitive connections between notation, sound, rhythm, and performance movement.

A significant problem is the imbalance between imaginative perception and analytical understanding of musical structure. Excessive simplification through visual or narrative imagery may weaken conscious comprehension of rhythmical organization, phrasing, and tonal relationships, while purely technical repetition frequently leads to mechanical memorization with rapid forgetting and unstable reproduction. Beginner learners also demonstrate limited concentration stability, high sensitivity to cognitive overload, and dependence on emotional engagement, which complicates long-term work with notation material [3, p. 149]. Under such conditions, overloaded associative stimuli may distract attention instead of strengthening memorization.

Additional difficulties arise from differences in dominant perceptual channels among children. Some learners rely more effectively on auditory anticipation, others on visual orientation or motor coordination, making standardized associative methods insufficiently flexible in group instruction. The situation is further complicated by the persistence of reproductive teaching models focused mainly on technical accuracy and repetitive practice, where associative thinking is often treated as secondary. Limited lesson duration, dense educational programs, and the simultaneous need to develop theoretical, rhythmic, technical, and interpretative skills also restrict the consistent integration of associative memorization strategies into beginner music training.

Improvement of pedagogical methods aimed at accelerating the memorization of musical notation in early music education requires the combination of structured associative interaction, multisensory perception, and gradual development of independent musical thinking. One of the most effective directions involves replacing prolonged mechanical repetition with short but systematically organized memorization cycles that combine auditory anticipation, visual orientation, rhythmic coordination, and emotional interpretation of musical material. Such organization reduces cognitive fatigue and increases the stability of memorized notation patterns.

Considerable attention should also be given to the sequential integration of associative techniques according to the age and perceptual characteristics of beginner learners. At the initial stage of instruction, musical phrases should be introduced through simple imagery, spatial comparisons, rhythmic gestures, and emotionally understandable expressive contrasts. As learners develop greater notation awareness, associative support should gradually shift toward structural comprehension of phrase architecture, harmonic movement, and interpretative continuity. This approach prevents dependence on superficial imagery while preserving the cognitive advantages of associative memorization.

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The effectiveness of memorization may additionally be strengthened through differentiated multisensory instruction. Visual learners benefit from graphical phrase segmentation, color-based rhythmic grouping, and spatial representation of melodic direction, whereas auditory-oriented children demonstrate higher retention through vocal imitation, internal hearing exercises, and intonational anticipation. Motor-oriented learners require coordinated tactile interaction with rhythm and keyboard movement to stabilize procedural memory. Flexible adaptation of memorization strategies to dominant perceptual channels significantly improves learning efficiency and reduces performance instability.

An important methodological recommendation concerns the integration of expressive interpretation into memorization processes from the earliest stages of training. Musical notation should not be presented exclusively as a technical symbolic system, but as an expressive artistic structure connected with movement, emotional states, dynamic contrasts, and phrasing logic. Such interaction increases concentration, strengthens long-term retention, and improves continuity of performance reproduction. Contemporary educational technologies may also support memorization through interactive notation visualization, rhythmic simulation, and synchronized audiovisual exercises, although digital tools should complement rather than replace the development of independent auditory imagination and conscious musical perception.

Conclusions. The study confirms that associative thinking functions as an effective pedagogical mechanism for accelerating the memorization of musical notation in early music education. It has been established that the coordinated interaction of visual, auditory, emotional, and motor associations strengthens the stability of musical memory, improves concentration, and increases the continuity of performance reproduction. The research demonstrates that associative memorization becomes most effective when integrated into a structured methodological sequence combining multisensory perception, rhythmic

coordination, emotional interpretation, and gradual development of independent musical thinking. The study also identifies key scientific and practical problems complicating the implementation of associative techniques, including insufficient methodological systematization, imbalance between imaginative and analytical perception, instability of learner concentration, cognitive overload, and limited adaptation of memorization strategies to individual perceptual characteristics of children. It is substantiated that effective memorization requires differentiated multisensory instruction and the integration of expressive interpretation into notation work from the earliest stages of training. Further research should focus on the development of adaptive methodological models for different age groups, empirical evaluation of multisensory memorization techniques in instrumental training, and the investigation of digital educational environments as tools for strengthening associative musical memory.

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