

Formation of Arithmetic Musical Competence in Students

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Abstract: *Objective:* The purpose of this study is to form the arithmetic musical competency of students on the basis of Al-Farabi's theoretical musical heritage. In this context, the work "The Great Book of Music" is of great importance. In this work, he gives not only a scientific explanation of the origin of sounds as properties of matter but also gives an idea of the arithmetic principles of the emergence of harmony and musical melodies.

Background: Musical competence is described as an ability and an aptitude to adequately perceive and emotionally respond (react) to music, to transfer musical perception into the ability to think using artistic images. In school, its formation occurs during the study of a discipline "Music", among special subject competencies *that form within this subject an arithmetic musical competence can be distinguished.*

Method: Judging from the musical theory composition method, Al-Farabi suggests an innovative method to improve the musical development of students with intellectual disabilities which consists of the individual preparation of a training plan.

Results: As a result of this study, it was determined that the problem of the formation of arithmetic musical competence in the learning process is relatively new and insufficiently studied. Arithmetic musical competence can be formed on the basis of teaching the method of the musical theory of composition Al-Farabi.

Conclusion: The experiment results allows for the conclusion about the advantages of the formation of musical competence of students via knowledge of music theory.

Keywords: Musical instruments, mathematical theory, musical competence, numerical art, interval.

INTRODUCTION

In the history of world music culture, there are milestones that signify a drastic expansion of scientific knowledge about music: consolidation of all preceding experience in this field presents a new and brave in its anticipation of oncoming scientific collisions comprehension of musical art [1, 2]. Researchers' thoughts time and time again reach into them, drawing from theoretical studies of the past insights into sources of contemporary culture and finding them greatly concordant with their scientific worldview. The name of the greatest representative of Eastern musical science Al-Farabi can be placed beside names of such prominent medieval scholars as Augustine and Boethius. They are responsible for creating cohesive teaching about music.

Abu Nasr Muhammad ibn al-Farabi (870-950) – the most influential Arab-Islamic thinker and encyclopaedist, who made a significant contribution into the development of philosophy, logic, natural science and exact sciences, holds a special place in

musical historiography [3]. Al-Farabi's theoretical musical legacy plays a fundamental role in the study of history and theory of music of the Middle and Near East. In this regard of great importance is his work "The Great Book of Music" (Kitab al-Musiqa al-Kabir). This work demonstrates that Al-Farabi is the most influential medieval musicologist. He provides not only a scientific explanation of the origin of sound as properties of the substance but also an insight into arithmetic principles of inception of harmony and musical melodies [4, 5]

According to the traditional interpretation of music as a discipline of mathematics, the reason Al-Farabi included it into this branch of classification is the reliance on numerical approaches to the expression of musical elements – sounds, rhythmic units (note values) – in the form of values and quantities, and also computing methods. In the "Great book of music", he notes: "Music is bound to mathematics because its goal is the study of sounds and everything that is connected to them in the form of values and quantities" [6]. The existence of various connections between arithmetic and music confirms that there is a need to form arithmetic musical competence in students with psychological disabilities.

Judging from the definitions of the term "competence", "musical competence", and the

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described above connection between arithmetic and music, arithmetic musical competence in students in this research should be understood as an integral development of an individual that reflects an aptitude for studying the subject that requires arithmetic proficiency, and also the ability to use arithmetic knowledge to solve various practical and theoretical challenges and problems encountered during learning activities. Competence emerges during the application of knowledge and skills to solve problems different from those that knowledge was absorbed. In modern education, Al-Farabi's musical theory composition method can be applied in teaching mathematics, music and music theory.

In the curriculum for the fifth and sixth grades of basic secondary education, the standard content of mathematics for the fifth grade consists of the following entries:

"Common fractions and operations with them (51 hours)".

Simple fraction. Reading and writing of common fractions.

The main quality of a common fraction.

Equality of fractions.

Proper and improper common fractions.

Mixed numerals.

The integer and fractional parts of a mixed numeral.

Converting improper fraction to a mixed numeral.

Depiction of a mixed number as an improper fraction.

Representation of common fractions and mixed numerals on a coordinate ray.

Getting common denominator of common fractions.

Comparing common fractions and mixed numerals.

Addition and subtraction of common fractions.

Addition of mixed numerals.

Subtraction of mixed numerals.

Multiplication of common fractions and mixed numerals.

Mutually multiplicative inverse.

Division of common fractions and mixed numerals.

Arithmetic operations with common fractions and mixed numerals.

Converting between decimals and fractions.

Standard content of mathematics for the sixth grade contains the following entries:

"Ratios and proportions (24 hours)".

Ratios.

Proportional ratio between two numbers.

Proportions.

The main quality of proportions.

Direct and inverse proportions.

Solving problems using proportions.

Computing percentages from a number and a number from percentages using proportions.

Students get acquainted with musical terminology in the fourth grade. Standard content of music for the fourth grade contains the following entries:

"World of sound" (7 hours), music – the world of sound.

Understanding notes.

Natural and artificial sounds Musical sounds.

Musical instruments [7].

Students receive a thorough explanation of musical terms in special musical schools. All arithmetic operations on ratios students learn during mathematics lessons, and their musical expression during music lessons. Taking into account Al-Farabi's musical theory composition method studying all aforementioned content of subject curricula will contribute to the formation of arithmetic musical competence in students and achieving the following important goals: to develop an interest to Al-Farabi's legacy in students; to form musical culture, numeracy; to develop musical perception, interest to music and music activities; to form the ability to structure information (situation), to compute mathematical ratios, to analyse and transform it, to interpret obtained results; to contribute to the development of memory, attention, logical thinking, creative talents, initiative and independence.

Among arithmetic musical competence there are elements, which form and are utilised on specific subject lessons, during realisation of integrative cross-curricular projects, in extra-curricular activities. The purpose of the research is the identification of forms and methods for the development of professional competencies of students with mental disorders in the lessons of individual music teaching.

MATERIALS AND METHODS

A quantitative side of established intervals is determined by a numerical correlation. Right here is the point of connection between music and mathematics,

the commencing of the mathematical theory of music. Musical intervals have different values. They can be divided and added. Therefore, a learner should be familiar with certain numerical ratios and the means of addition and subtraction of these ratios. Taking into account practical orientation of modern education, the main result of educational establishment's activity apparently must not be the system of knowledge, skills and proficiencies by themselves, but a set of competencies that enables students' future conduct in society. First of all, these core competencies include, according to A.V. Khutorskoy, value orientation, cultural, learning and cognitive, personal, information, communication, social and labour competencies [8].

Alongside the outlined core competencies, common for all subject fields, subject competencies – unique abilities that are necessary for effective execution of specific actions in a specific subject field and include highly specialised knowledge, distinctive subject skills, proficiencies, thinking patterns. Subject competencies are formed within a study of a specific educational subject. In particular, musical competence is described as an ability and an aptitude to adequately perceive and emotionally respond (react) to music, to transfer musical perception into the ability to think using artistic images. In school, its formation occurs during the study of a discipline "Music", among special subject competencies that form within this subject an arithmetic musical competence can be distinguished. Judging from the musical theory composition method, Al-Farabi suggests an innovative method to improve the musical development of students with intellectual disabilities which consists of the individual preparation of a training plan [9, 10].

Throughout 2019, the authors conducted an experiment to identify forms and methods for the development of students' musical competencies in individual music lessons. The study engaged 120 students with intellectual disabilities from the Kazakh National Pedagogical University named after Abay, Almaty, Republic of Kazakhstan. Students were divided into two groups of 60 people - control and experimental groups. During individual music lessons, the following competencies were formed: technique of using the instrument, without which it is impossible to embody the musical text without the knowledge of elementary theory; technique of managing the performing process; technique of control of psychophysical processes.

Instrumental training should give students with mental disorders the skills to play notes, which will

allow them to independently learn unfamiliar songs, play and sing at the same time, perform some of the available theatrical pieces while listening to music. Simultaneously with mastering playing the instrument, students need to master the basics of musical notation. Individual music lessons begin with elementary theoretical concepts of music: sound, its properties (pitch, duration, strength, timbre); rhythm; intervals, chords; harmony (tonality, scales); melody. Without knowledge of theory, students cannot learn to play the accordion. To acquaint students with various genres, styles and forms of music and practical application in the lessons of individual music teaching, collections of instrumental pieces have been developed.

During the lessons, specific tasks were solved: the development of auditory, visual, and reading skills that help to navigate the purely musical nature of artistic images (rhythm, tempo, pitch orientation, timbre, colour, composition) in their emotional content. Musical performing activity includes a variety of specific components, such as: the level of students' performance training, intellectual base, artistic emotionality, pitch hearing, orientation in the musical text, musicality. These components create the preconditions for the comprehensive development of musical performance competence. For the formation of musical performance competence, musical abilities are required: musical memory, ear for music, a sense of rhythm. The memory issue is one of the most important in psychology and pedagogy.

The experiment envisaged the solution of the following tasks - to determine the average level of musical development formed in the spontaneous experience by the control group; determine the average level of musical development formed after the experiment carried out using the Al-Farabi method by the experimental group. To solve the objective of the experiment, the following tasks were given. Task 1 aimed to reveal the presence of developed melodic hearing, voice range, developed diction, and auditory attention in students. Task 2 aimed to reveal the presence of developed timbre hearing and auditory attention in students. Task 3 was aimed at determining whether students have pitch hearing, auditory attention. Task 4 was aimed at revealing the presence of students' musical memory based on the previously studied musical material. Task 5 was aimed at determining the presence and development of a sense of rhythm in students. Task 6 was aimed at identifying the presence of creative skills among students, the ability to compose a melody and rhythmic pattern.

RESULTS

Analysis of the results of musical and creative abilities is presented in Tables 1-3.

Figure 1 gives a comparative analysis of the average value of musical development levels of students with psychological disabilities in the control and experimental groups of the experiment.

As can be seen from Figure 1, indicators for all levels of musical development of students in the experimental group increased. Thus, having analysed the results obtained, we come to the following conclusions:

1. Melodic hearing. Students learned to listen to the melodic line to determine the nature of its movement.
2. Timbre hearing. Students easily distinguish between different timbres, give them a figurative characterisation.
3. Sound-pitch hearing. Students have a wider range of voices, and they know how to use it, intoning the sounds of the fret purely in the interval from a second to a fifth in various syllables.

Table 1: Average Value of Musical Development Level of Students with Intellectual Disabilities in the Control and Experimental Groups

	Sense of pitch			Sense of rhythm			Musical memory	Creative ability
	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6		
Control group	A	L	A	A	L	A	A	L
Experimental group	H	A	H	H	A	H	H	A

Note: Evaluation criteria: H - high level; A - average level; L - low level.

Table 2: Average Value of Musical Development Level of Students with Intellectual Disabilities in the Control Group

Levels	High		Average		Low	
	Quantity	%	Quantity	%	Quantity	%
Task 1	0	0	33	55	27	45
Task 2	0	0	9	15	51	85
Task 3	0	0	42	70	18	30
Task 4	0	0	51	85	9	15
Task 5	0	0	24	40	36	60
Task 6	0	0	39	65	21	35
Average value		0		55		45

Table 3: Average Value of Musical Development Level of Students with Intellectual Disabilities in the Experimental Group

Levels	High		Average		Low	
	Quantity	%	Quantity	%	Quantity	%
Task 1	48	80	12	20	0	0
Task 2	24	40	36	60	0	0
Task 3	54	90	6	10	0	0
Task 4	45	75	15	25	0	0
Task 5	21	35	39	65	0	0
Task 6	51	85	9	15	0	0
Average value		67.5		32.5		0

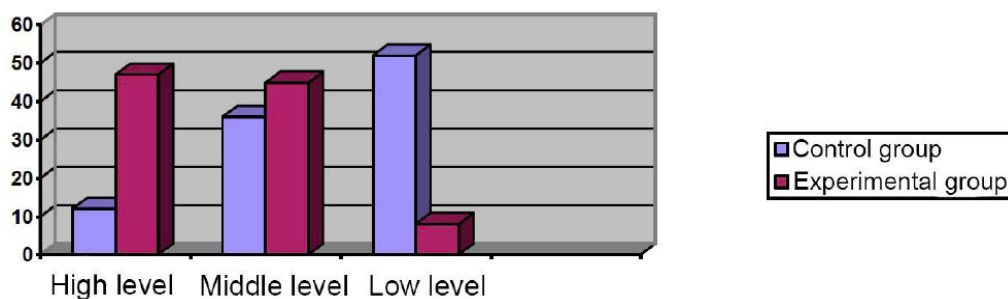


Figure 1: Comparative analysis of the levels of musical development of students in the control and experimental groups.

4. Sense of rhythm. Students have experience with rhythm tasks. They know how to perceive a rhythmic pattern by ear and perform it.
5. Musical memory. Students have a fairly large body of knowledge of musical works. They can figuratively perform many of them with sufficient accuracy, reproducing the character and image of a composition.
6. Creative skills. Creative skills did not cause difficulties for students. The compositions contained a variety of characters and images created by various means of expressive melody - rhythmic structure, dynamics, originality of the movement of the melodic line.

DISCUSSION

Al-Farabi's musical works have been repeatedly examined in Oriental studies in special monographic works [3, 11], as well as in musical research on the Near and Middle East [12, 13]. In Russian-language literature, Al-Farabi's theoretical musical views were analysed by I.O. Radzhabov [13], A. Dzakhid [14], I.I. Zemtsovsky [15] *et al.*, excluding the monograph of O. Matyakubov [12], which offers a generalised description of theories about modes, rhythm, musical instruments. In the works of the aforementioned authors, the content of the theory was examined in the context of general theoretical and aesthetic questions.

Al-Farabi's theoretical musical views are reflected in the works of A.K. Kubsov [9]. Recently a lot of attention is given to the translations of Al-Farabi's different compositions into the Kazakh language. Al-Farabi's music is among the mathematical sciences. Music is a world of sounds and sound ratios. The main element is sound. In his compositions, Al-Farabi defines sound similarly to antique, as well as modern understanding about it. Sound is an oscillation of a physical body (solid or soft), propagated into motion by

force (impact) of another physical body. Sound has four main parameters of measurement: pitch, duration, timbre and loudness [12, 16].

Al-Farabi considers musical sound in different aspects – as a physical and geometric body, an arithmetic number. Moreover, Al-Farabi further distinguishes between the sound of a human voice – “natural” and the sound of instruments – “artificial”. The main area of research on sound is its relationships in a pitch system. When studying modes pitch structures are taught in relation to sounds that comprise them. Interval is, first and foremost, coordination of sounds, and then it is a coherent whole, where its euphony or cacophony are examined in relation to other intervals. While determining intervals, Al-Farabi assumes that the length of a string is the most important factor that makes it easier to determine the position of one tone in relation to the other [17, 18].

CONCLUSION

Works on music by the great scientist Al-Farabi are of great interest for musical and mathematical education in the Republic of Kazakhstan. Treatise of a scientist who was born and resided on the territory of modern Kazakhstan included ideas about the necessity of teaching children musical art. Many of them, including Al-Farabi, were adherents of the rational scientific school in musical pedagogics. They believed that not only feelings but the mind is necessary to comprehend the basics of musical arts. This idea is extremely valuable for the modern step in the development of musical education in Kazakhstan. It can be taken as a basis for learning Kazakh national works, works of academically-focused works of musical art written by Kazakhstan composers. The perception and execution (singing) of these works, according to Al-Farabi's idea, must include rational moments: discussion, reflection on music, comparisons with literary sources, poetry. Musical works should be given an aesthetic evaluation.

Al-Farabi emphasised the educational role of music. He thought that music and numerical arts play a significant educational role, because these sciences educate students, make them more thoughtful, show the way to further learning. In conclusion, we should note that the usage of Al-Farabi's musical legacy in modern education in schools contributes to the formation of arithmetic musical competence in students with mental disorders and increases the efficiency of the educational system as a whole.

The results of the experiment allow concluding the soundness of the students' musical performance competence formation via knowledge of music theory because, in order to form musical performance competence, musical abilities are required: musical memory, timbre hearing, a sense of rhythm.

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