Música Hodie | ISSN: 2317-6776 DOI: 10.5216/mh.v24.79319

Improvement of Musical Technique in Playing Wind Instruments: Individual Approach and the Use of Digital Innovations

Aperfeiçoamento da Técnica Musical na Performance de Instrumentos de Sopro: Abordagem Individual e Uso de Inovações Digitais

Tianlong Huang
Department of Orchestral Instruments Music Education, Shenyang Conservatory of Music, Shenyang, China
huang571657@outlook.com

Abstract: The mastery of performing musical pieces using wind instruments depends on the musician's level of preparation. The objective of this article is to investigate the influence of the teaching approach employed in wind instrument instruction on the improvement of musical technique. The study was based on the recruitment of control (Group 1) and experimental (Group 2) groups. Group 1 was taught using traditional methods, while Group 2 was taught using an updated methodology incorporating an individualized approach to instruction and the use of the Virtual Trumpet digital application. It was determined that students in the experimental group were able to achieve higher trumpet playing scores, primarily attributed to breathing technique and embouchure ($p \leq 0.05$). Additionally, students in Group 2 exhibited higher endurance scores (the highest scores) compared to students in Group 1 (scores ranging from 3 to 5), attributed to the carefully designed individualized teaching approach. It was found that the overall quality of performance among students in Group

2 corresponded to grades of 4 and 5. The practical significance of this study lies in the potential for improving trumpet instruction methods by tailoring them to individual musicians' capabilities.

Keywords: digital applications, individual approach, intensity, performance breathing, traditional instruction

Resumo: O domínio da execução de peças musicais com instrumentos de sopro depende do nível de preparação do músico. O objetivo deste artigo é investigar a influência da abordagem de ensino empregada no ensino de instrumentos de sopro no aprimoramento da técnica musical. O estudo baseou-se no recrutamento dos grupos controle (Grupo 1) e experimental (Grupo 2). O Grupo 1 foi ministrado utilizando métodos tradicionais, enquanto o Grupo 2 foi ministrado utilizando uma metodologia atualizada que incorpora uma abordagem individualizada de instrução e o uso do aplicativo digital Virtual Trumpet. Foi determinado que os alunos do grupo experimental conseguiram obter pontuações mais altas no trompete, atribuídas principalmente à técnica de respiração e embocadura ($p \leq 0,05$). Além disso, os alunos do Grupo 2 apresentaram pontuações de resistência mais altas (as pontuações mais altas) em comparação com os alunos do Grupo 1 (pontuações variando de 3 a 5), atribuídas à abordagem de ensino individualizada cuidadosamente elaborada. Verificou-se que a qualidade geral do desempenho entre os alunos do Grupo 2 correspondeu às notas 4 e 5. O significado prático deste estudo reside no potencial para melhorar os métodos de instrução de trompete, adaptando-os às capacidades individuais dos músicos.

Palavras-chave: aplicações digitais, embocadura, resistência, abordagem individual, intensidade, respiração performática, instrução tradicional.

Submetido em: 10 de maio de 2024
Aceito em: 1 de outubro de 2024
Publicado em: novembro de 2024

1. Introduction

Musical instruments play an important role in various cultures and are an integral part of the musical art. The study of musical instruments and their influence on the organs and systems of the human body is an important task for musicologists and specialists in the field of medicine. An aspect that requires more in-depth research is the effect of playing wind instruments on the facial muscles of musicians (Moss et al., 2012).

To play wind instruments, such as flute, saxophone, trombone, and trumpet, a musician needs not only technical skills but also the ability to control and coordinate facial muscles. These instruments require the musician to breathe correctly and control the embouchure (the shape of the lips and the position of the jaws) and tongue flexibility to produce various sound effects. All these actions are performed by the facial muscles and can affect their condition and function (Lasseron, 2008).

Some scientific papers addressed the effect of playing wind instruments on the facial muscles (Moss et al., 2012; Lasseron, 2008; Chesky et al., 2002). A study in the field of music ergonomics focuses on the facial electromyography of musicians playing the flute. Researchers have found that playing the flute intensifies the activity of the facial muscles (especially the lips and cheeks). This fact indicates a significant load on these muscles during the performance and can lead to fatigue and possible muscle imbalances in musicians (Chesky et al., 2002).

Another study conducted among professional saxophonists revealed the effect of playing the saxophone on facial muscles. Using the methods of surface electromyography, the study showed that saxophone playing stimulates various facial muscles, such as lips, cheeks, and chin. It was found that their activity can cause muscle spasms, fatigue, and even pain in musicians (Garnett et al., 2022).

A study in the field of orthodontics examined the effect of playing wind instruments on facial muscles in adolescents. The results showed that musicians playing wind instruments have

stronger and more developed facial muscles compared to the control group. However, some of them also experienced symptoms associated with facial muscle overload, including jaw pain and headaches. During the instructional process, it is important to consider the positioning of the jaw, as it impacts the attainment of artistic performance, alterations in sound quality, and the alleviation of tension (Trollinger and Sataloff, 2019).

These studies indicate that playing wind instruments can have both positive and negative effects on the facial muscles of musicians. The understanding of this influence can be useful for developing effective prevention and rehabilitation methods for musicians playing wind instruments. Further research in this area would expand our knowledge and contribute to improving the health and well-being of musicians.

1.1 Literature review

Some studies have focused on measuring muscle activity using electromyography (EMG). For example, a study conducted among trombonists showed that playing the trombone leads to intense activation of facial muscles, especially in the area of the lips and cheeks. It was also found that the level of muscle activity depends on the performance technique and the complexity of the musical composition. These results emphasize the importance of appropriate technique and control of facial muscles to prevent muscle weakness and possible injuries (Kok et al., 2021).

Other papers have focused on studying the biomechanics and movement of facial muscles while playing wind instruments. For example, a study conducted among flutists used a method of analyzing facial movements using a three-dimensional optical system. The results showed that flute playing requires complex coordination movements of the lips, tongue, and jaws. This fact indicates that this instrument has a substantial effect on the facial muscles. Therefore, there is a need to train and develop

the appropriate muscles to achieve optimal results and prevent possible damage (Herrmann et al., 2021).

Some studies have also drawn attention to the effect of playing wind instruments on the joints and bone structures of the face. A study conducted among professional trombonists found a link between the frequency and intensity of playing and the risk of traumatic changes in the temporomandibular joint (Trollinger and Sataloff, 2021). The results underline the need to take care of health and use correct playing techniques to prevent possible damage to joints and bones.

It is important to develop effective prevention and rehabilitation strategies, including proper playing techniques and regular exercises according to the recommendations of specialists. Further research in this area will broaden our knowledge about the effect of playing wind instruments on facial muscles. Thus, it will be possible to develop more individual and effective approaches to the health and training of musicians. The research can provide a basis for the elaboration of recommendations and guidelines for musical educational programs and professional activities of musicians playing wind instruments.

The position of the lips is decisive when playing the trumpet. The correct and stable position of the lips allows a musician to control the pitch and produce various technical effects. Erroneous or incorrect position of the lips can cause excessive tension of the facial muscles, leading to fatigue, pain, and even injuries. Due to incorrect lip positioning, air leakage may occur, which affects the quality of melody execution (Van der Weijden et al., 2023; Nwobi and Ojukwu, 2022).

Lip pressure control is another important aspect of playing the trumpet. Excessive or insufficient pressure on the lips can negatively impact the sound of the instrument and the health of the musician. Excessive pressure can overload the lip muscles and cause muscle weakness, while insufficient pressure can make it difficult to produce high-quality sound and require additional

effort from the musician. Pressure control affects the natural extraction of sound, which in turn influences the quality of sound sequence continuity (Clemente et al., 2020; Dueppen, 2021; López-Pineda et al., 2023).

The strength of the contact with the mouthpiece also affects the health of the musician. The mouthpiece is the main source of sound on the trumpet, and improper or excessive pressure on the mouthpiece can cause tension and discomfort in the area of the lips and jaws. Correct contact with the mouthpiece, balanced between sufficient support and minimal tension, is key to maintaining the health and comfort of musicians. The utilization of video instructions enables the attainment of higher outcomes, employing precise diagrams to cultivate dynamism in performance execution (Sambre, 2021).

It should be noted that the influence of each factor may vary depending on the overall physical fitness of the musician, the regularity of training, and the professional level. Some studies indicate that incorrect trumpet playing technique can lead to various problems, including a lack of muscle strength, pain, and even the development of chronic conditions, such as overload syndromes and traumatic joint changes (López-Pineda et al., 2023; Sambre, 2021). The teaching and training of trumpet musicians should cover these factors. In this case, it will be possible to prevent possible problems and maintain their health and well-being throughout their musical career.

An analysis of the literature on the influence of trumpet playing on the health and facial muscles of a musician reveals several important aspects and research results. There are a significant number of scientific articles, publications, and books that address this issue and offer various recommendations or solutions (Van der Weijden et al., 2023; Dueppen, 2021; Sambre, 2021). One of the key aspects considered in the literature is the position of the lips when playing the trumpet. Many authors point out the importance of the correct position of the lips. It helps achieve optimal sound control and prevent possible damage

and injury (Herrmann et al., 2021; Van der Weijden et al., 2023). The literature offers various techniques and exercises aimed at developing and strengthening the lip muscles and their correct positioning (Nwobi and Ojukwu, 2022).

It is essential to note that the impact strength of each factor may vary depending on the musician's overall musical training, regularity of practice, and professional level, as explored in the presented studies. Emphasis was predominantly placed on lip positioning, while descriptions of other criteria were relatively sparse.

1.2 Problem statement

As mentioned above, the quality of playing wind instruments, such as the trumpet, depends on many factors – muscle strength, the correct setting of breathing, and the individual characteristics of a musician. Despite the significant scope of research devoted to this problem, some issues still need clarification. In particular, there is a gap related to new techniques that address all these factors. Standard training programs, which are associated with the absence of innovative mechanisms and involve classroom-based instruction with interaction between the teacher and the student, may not always improve results and fully reveal the musician's abilities. At the same time, it is necessary to focus on muscles, the breathing system, and the position when playing the trumpet. The development and testing of these techniques is an actual direction in the fields of physiology, music, and pedagogy. These interdisciplinary directions can give practical results, making it possible to improve the performance of musicians, for example, the quality of their playing. In this paper, the authors have attempted to address this issue. We have developed and tested a technique that improved breathing and embouchure skills during the performance.

The purpose of the paper is to develop and test a new technique centered on proper breathing and an embouchure setting for the

trumpet performance of music school students. According to the purpose, the study rests on the following points:

a. individual lessons and training taught students to set an embouchure;
b. students performed exercises based on directed breathing while playing the trumpet (the management of breathing entails the utilization of a specific airflow to control sound production, impacting overall timbre, dynamics, and so forth.);
c. the training period was long (6 months).

We have set the following research objectives:

a. form the proper breathing of the students;
b. develop embouchure setting skills;
c. assess the level of the performing range;
d. unify the wind playing technique (detache (it represents an unaccented stroke, which influences the creation of dynamic nuances in sound) or legato (it constitutes a technique for smoothly connecting sounds));
e. increase the indicators of endurance and quality in performance.

2. Materials and Methods

2.1 Sample

The study took place in 2019-2022 in a music school in Beijing (PRC). The study involved 48 students equally divided into Group 1 (control) and Group 2 (experimental). There were 16 boys and 8 girls in Group 1, 15 boys and 9 girls in Group 2. The majority of participants in both groups were young men since playing the trumpet is more popular among male students. At the beginning of the experiment, the average age of students in Group 1 was 19.2 ± 0.2 years; in Group 2, it was 19.4 ± 0.2 years. For the

research, first-year students undergoing trumpet instruction were recruited. The selection of these participants was based on the potential to determine the effectiveness of the chosen instructional mechanisms, independent of the influence of various additional factors. The selection of musicians among the students was random. Nevertheless, we excluded musicians who differed in physique, musical skill, and physical fitness parameters. The exclusion took place at the second stage of selection conducted by members of a musical jury. The same jury subsequently evaluated the success of musicians in each group at all stages of the study.

2.2 Research design and ethical statement

The selection criteria were similar characteristics of body and physical shape, as well as the average level of musical skills. Before entering the school, the students did not study music. However, they managed to complete the first course and received basic knowledge of music theory and trumpet playing. At the beginning of the study, all of them enrolled in the second year.

This study took into account physiological parameters and musical theory (proper breathing, embouchure). Initially, emphasis was placed on identifying parameters contributing to the improvement of trumpet playing skills. An important aspect was the management of breathing and manipulation of the embouchure. These indicators hold significance during trumpet performance, as proper breathing, or musical breathing, refers to a special breathing technique used by musicians on wind instruments to produce sound. This breathing technique allows the musician to control the flow of air through the instrument and create musical notes. In this case, the musician uses deep diaphragmatic breathing to provide sufficient air and control its flow to achieve optimal sound and expressiveness. An embouchure constitutes a part of a wind instrument that serves to connect the mouthpiece to the body of the instrument. It is usually made of a material with good tightness, such as rubber or leather. It allows

the musician to create a tight connection between the lips and the mouthpiece to control the flow of air and produce sound. Embouchure is also used to adjust the resistance and change the timbre of the instrument; to do this, the musician can change the space between the mouthpiece and the body. The refinement of the embouchure technique influences the smoothness and volume of musical performance. The manipulation of the embouchure impacts sound control, its tone, and the range of performance.

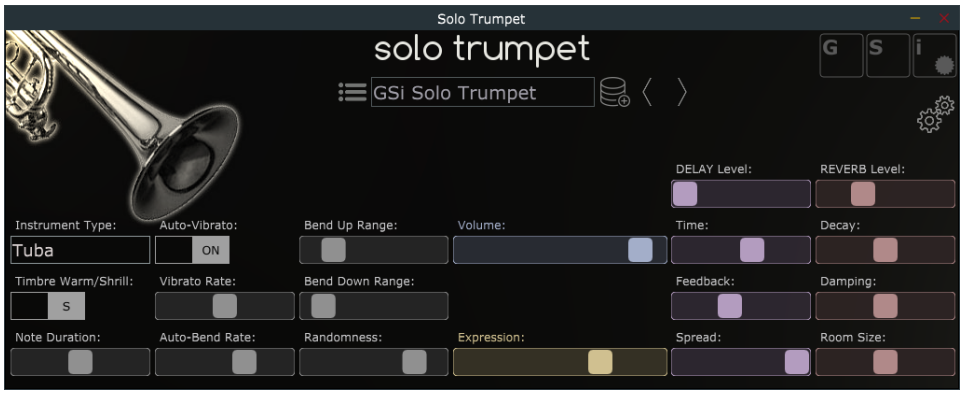
The study complies with international norms of ethics and morality. It also observed the principles of anonymity and confidentiality of the received information. Each of the participants signed a written contract guaranteeing them these rights. The contract also contained information about the goals and methods of research. The study was approved at the meeting of the Ethics Committee of the [BLINDED].

2.3 Research methods

Group 1 studied trumpet playing under the standard system of musical education at the school (control group). Group 2 received individual training developed within this study. The programs underwent corrections every 14 days during the first three months of training. The corrections depended on the obtained data on the achieved levels of trumpet playing. The programs for Group 2 were prepared three months in advance and contained the same number of exercises (experimental group). However, the number of some exercises could vary depending on their complexity. The main part of each lesson consisted of two blocks – homework and learning new material. In some cases, the old material was revised. The classes employed an original technique that implied an individualized selection of exercises according to such parameters as the breathing technique and the physiological features of the students' embouchure. Thus, it was possible to monitor the quality of exercise execution.

In the instruction of the experimental group, digital technologies were employed, facilitating the automation of instruction and ensuring comprehension of exercise execution mechanisms. The Virtual Trumpet application (Figure 1) facilitated the refinement of musical sounds, influencing their beauty and smoothness of execution. Additionally, the application was designed to enhance the clarity of articulation. Throughout the instruction process, efforts were made to develop a sound attack, rhythm, and vibrato, and to explore the nuances of performing individual compositions, aligning with the content and style of the musical piece, thereby aiding in the understanding of musical passages. In the experimental group, instruction was conducted under the supervision of educators, involving the utilization of an individualized approach to teaching.

Figure 1 – Features of the virtual trumpet digital application functionality



In Group 1, classes applied a different principle: a lesson – homework assignment – the checking of the assignment – the presentation of new material. In the first month, training focused on mastering trumpet playing technique. In the subsequent lessons, students of this group learned musical works (pieces, studies, and scales). The training involved the methods adopted in the general education program of the school. In the instruction of students in Group 1, an individualized approach was absent, entailing the delivery of lectures and practical sessions for the entire group

of students. During the completion of homework assignments, students also explored new topics, involving the execution of theoretical and practical exercises, which were randomly evaluated among selected students. In Group 1, musical examples and the study of theoretical material were utilized for breath management, endurance maintenance, and other criteria, necessitating repetition by students for comprehension of the material covered. Instruction in Group 2 involved interaction between each student and the educator to grasp all proposed educational topics.

Initially, the refinement of trumpet playing skills under the supervision of educators was determined. The assessment of outcomes was based on evaluating the quality of embouchure positioning and correct breathing. Additionally, the research aimed to identify parameters related to sound range development and sound unification speed. Determining these indicators involved assessing the exercises performed and understanding the nuances of utilizing these parameters during trumpet playing. Results were gathered throughout the entire instructional period and based on a final examination, thus avoiding reliance solely on the results of a single exam. In Group 1, educator-student interaction occurred simultaneously with all students, precluding an individualized approach. Instruction among the two student groups was conducted three times per week, ensuring equal research conditions.

To compare the obtained results, the following criteria were utilized:

a. The dynamics of mastering the techniques, rate, and correctness of breathing for trumpet playing (criterion 1).
b. The same parameters for embouchure (criterion 2).
c. The rate and quality of improving the musical range (criterion 3).
d. The standardization of detache and legato techniques (criterion 4).

e. The parameters of endurance, quality, and stability in a musical performance (criterion 5).

To define criteria 1 and 2, the quality of students' performance of various melodies was considered, characterized by variations in speed and duration of individual notes. Determining mastery of range (criterion 3) was associated with ensuring the quality of performance across different pitches, implying adherence to clarity and articulation. Accuracy in the execution of note endings was also taken into account, intertwined with the overall expressiveness of the melody. Defining legato strokes was linked to student's ability to combine sounds with a consistent dynamic while maintaining softness and roundness of tone. The precision in using legato strokes was associated with the ability to maintain note durations and intervals. The duration of pauses relates to the performer's sensations, yet it must harmoniously correspond to the presented piece. Results were presented following research based on the comparison of students' initial and final capabilities. These results were obtained through observational methods, facilitating the assessment of progress in trumpet playing instruction.

In the second stage of the research, endurance of performance was also determined. This criterion was associated with the quality and consistency of performance across compositions, irrespective of the complexity of the piece.

The third stage of the research, conducted subsequent to instruction and the determination of five criteria, involved a comparative analysis of material comprehension between male and female participants within each group. This stage was associated with the thorough examination of the most crucial criteria (1, 2, 5), as they primarily dictate the quality of trumpet playing and the ability to uphold aesthetic singing. The selection of these criteria was also motivated by their suitability for statistical analysis, given the possibility of scoring students' results on a 5-point scale. The distribution between male and female participants was undertaken to provide granularity to

the research findings and to understand the level of material comprehension among students. The quality of trumpet playing was linked to the mastery of playing technique and the expression of emotion.

For statistical analysis, the Statistica 10.0 program was used. To compare the results in different groups, the study employed the Student's t-test for independent samples (Matsunobu, 2023). To calculate the difference between the average scores received by girls and boys for each of the groups, we used the Kruskal-Wallis test (Nicolas and Carbonell, 2019). The differences are significant at $p \leq 0.05$.

3. Results

Figure 2 – The results of proper breathing learning in Groups 1 and 2

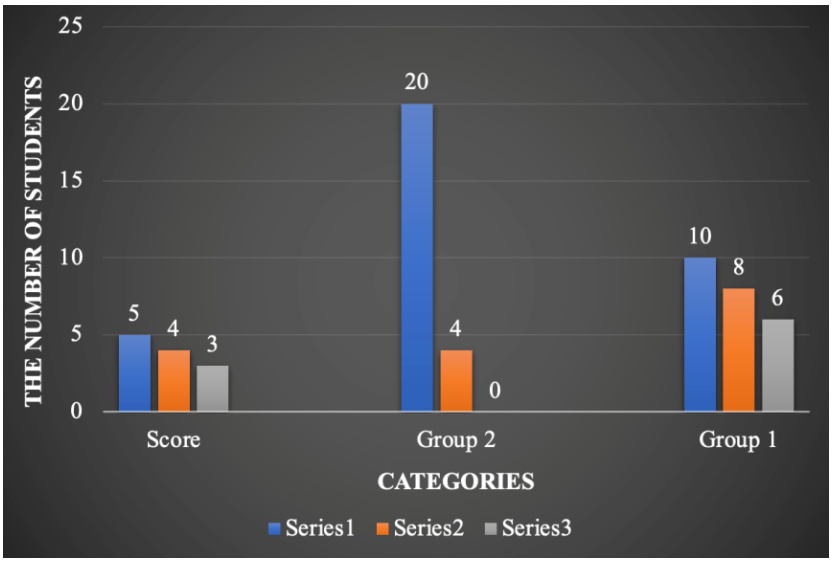
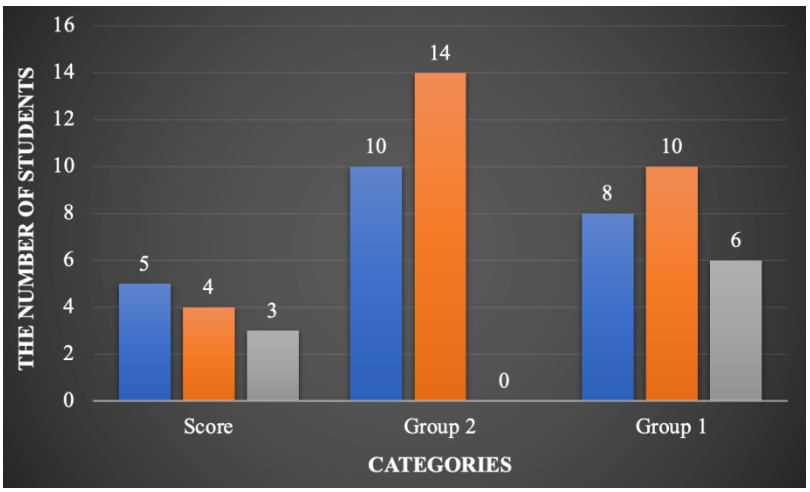


Figure 2 shows the significance of differences in proper breathing learning in Groups 1 and 2. The assessment was based on the following scale: the score "5" corresponds to 2 months spent on mastering breathing techniques; the score "4" corresponds to 2-4 months spent on training; "3" corresponds to 4 months. As

Figure 2 shows, all students in Group 2 received 4 and 5 ($p \leq 0.05$ for the number of students who received 4, as well as for Group 1 students who received excellent grades). In group 1, some students' scores were 3. As for criterion 2, the assessment followed the same principles (Figure 3).

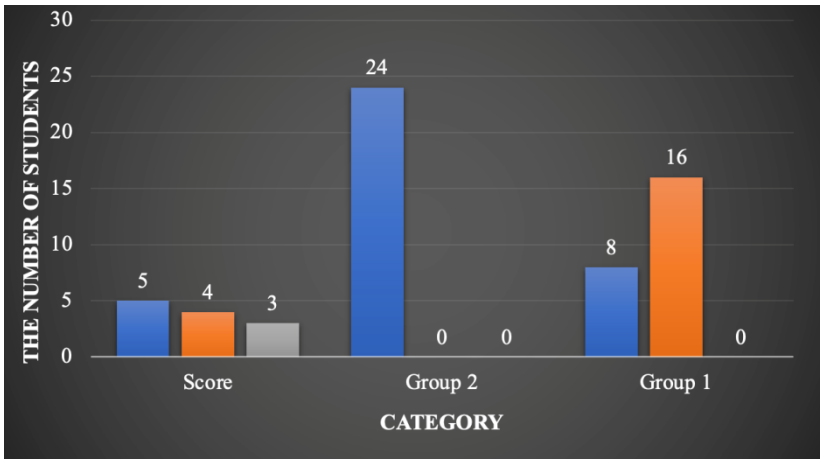
Figure 3 – The results of embouchure learning in Groups 1 and 2



According to the data in Figure 3, a quarter of the students from Group 1 showed low academic performance. At the same time, in Group 2 the academic performance was high. Confidence levels between groups: for a score of 5, it is $p \leq 0.08$, for a score of 4, it is $p \leq 0.05$. It follows that Group 2 showed significantly better results regarding breathing and embouchure compared to Group 1 (Figure 2 and Figure 3).

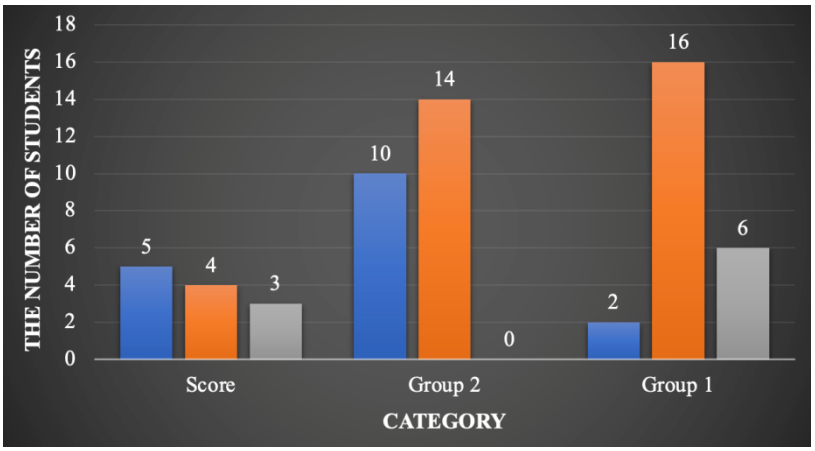
Figures 4 and 5 present the results for criterion 3. These figures show the range (maximum and working) parameters that students of both groups managed to achieve.

Figure 4 – The indicators of the maximum range parameters in Groups 1 and 2



Regarding the number of students who received 5 points, the differences between Groups 1 and 2 were significant at $p \leq 0.01$.

Figure 5 – The parameters of the working range in Groups 1 and 2

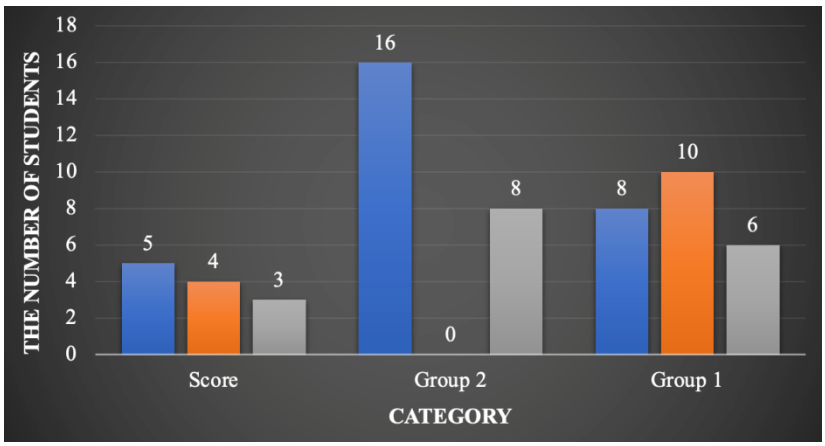


According to this parameter, there are significant differences in the number of students from Groups 1 and 2 who scored 5 points: $p \leq 0.01$. The difference in the number of students who scored 4 points is significant at $p \leq 0.09$. Those students who worked with a range of 2 octaves scored 5 points; those who used 1.5-2 received 4; the score for up to 1.5 octaves was 3. As Figure 4 shows, all

students from Group 2 achieved the best results according to the maximum range criterion, while students from Group 1 were twice as likely to receive 4.

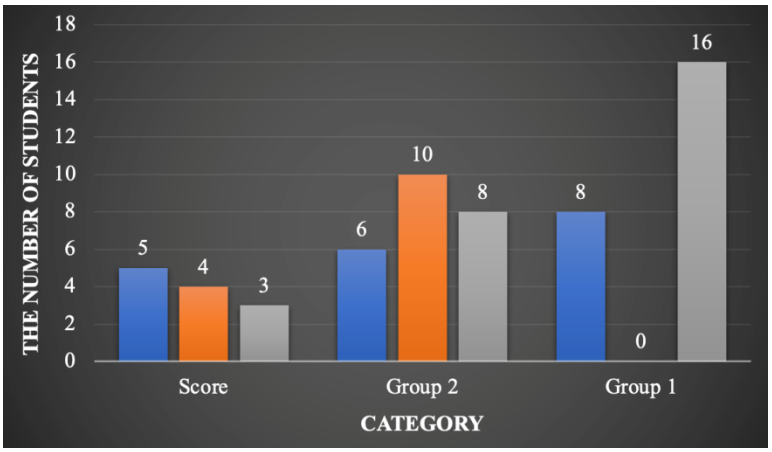
According to the second indicator of the range, students from Group 2 attained results of 5 and 4 points. At the same time, one-sixth of the students from Group 1 received 3 (Figure 5). Figures 6 and 7 present the final results according to the fourth criterion. To receive 5, students had to learn standard detache in up to 90 days; for more than 90 days but up to 180, students could score 4; for more than 180, they received 3. For the second parameter, legato, these time limits for learning were longer: 5 = up to 180 days; 4 = from 180 to 240; 3 = more than 240 days.

Figure 6 – The rate of standard detache learning in Groups 1 and 2



Significantly more students from Group 2 scored 5 on the exam ($p \leq 0.01$), which implied receiving grades on the exam, taking into account the overall learning outcomes. At the same time, some students from this group scored 3 ($p \leq 0.07$).

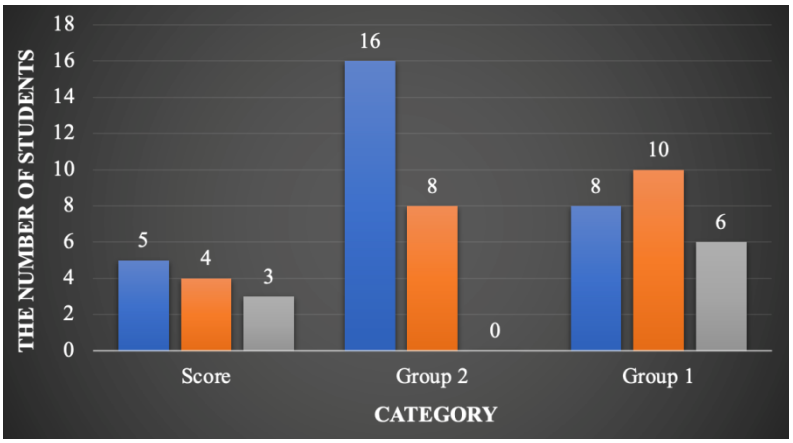
Figure 7 – The rate of standard legato learning in Groups 1 and 2



For the parameter shown in Figure 7, most students from Group 1 attained results of 3 ($p \leq 0.01$). Nevertheless, the number of students who scored 5 was approximately equal in both groups ($p \leq 0.08$). It is interesting to note that for standard detache, most students from Group 2 received the highest score, while one-third scored 3. For Group 1, the distribution of scores was almost even (Figure 6). As for legato, the trend is the opposite: one-third of the students from Group 1 received 5 and two-thirds had 3. In Group 2, the distribution was almost even (Figure 7).

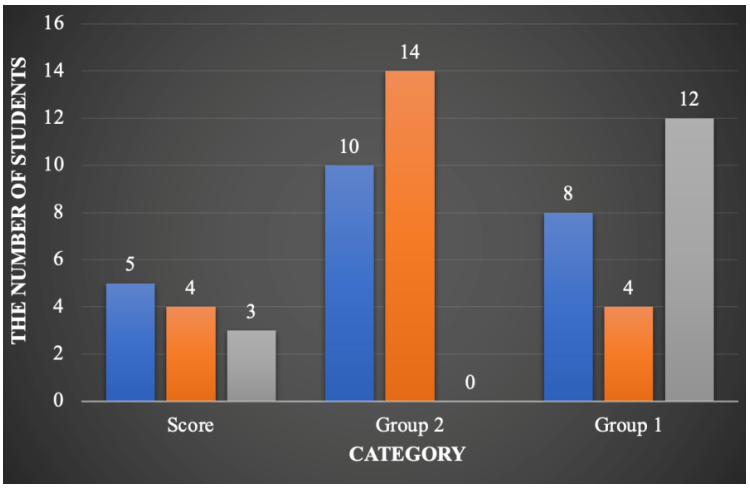
The students mastered performance quality and endurance (criterion 5) at the end of the course, during the last month. During the last 5 lessons, they repeated the material from the previous lessons. All students performed two classical compositions (*Minuet* by Bach and *Missa Solemnis* by Beethoven). In the control lesson, the students performed these pieces several times, demonstrating the level of their endurance. Figures 8 and 9 show the results. Accordingly, for performing the composition more than three times, students scored 5; 2-3 performances brought 4; for only 1 performance, students received 3. As for the performance quality, the assessment was as follows: 5 = 1 mistake; 4 = from 2 to 3; 3 = 4 or more.

Figure 8 – The levels of endurance in Groups 1 and 2



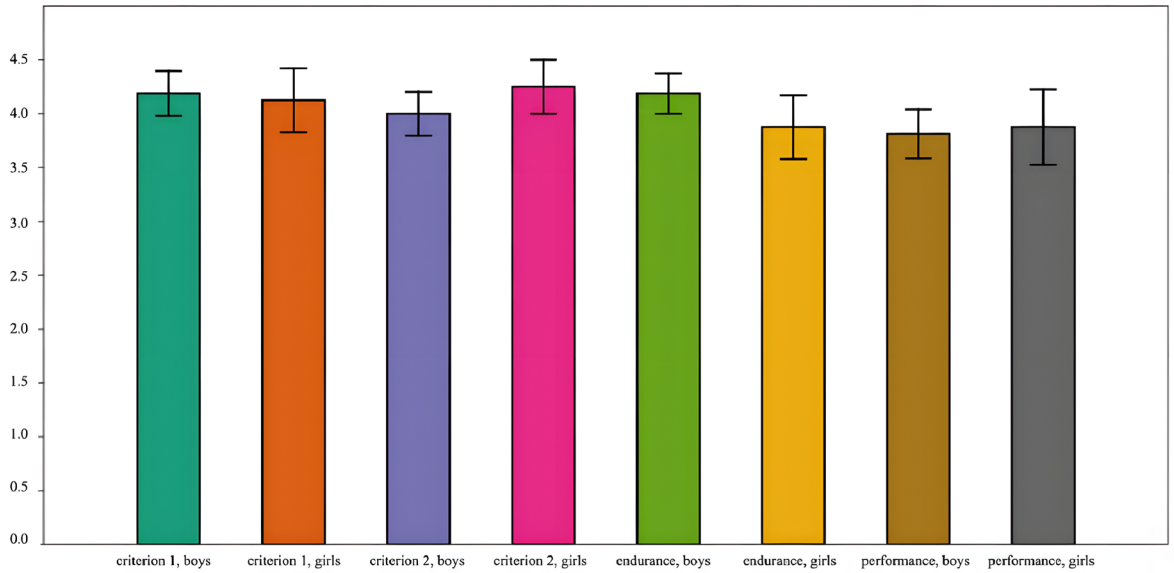
The number of excellent students in Group 2 was significantly higher ($p \leq 0.01$). The number of good students was also trending towards Group 2 ($p \leq 0.07$).

Figure 9 – The indicators of performance quality in Groups 1 and 2



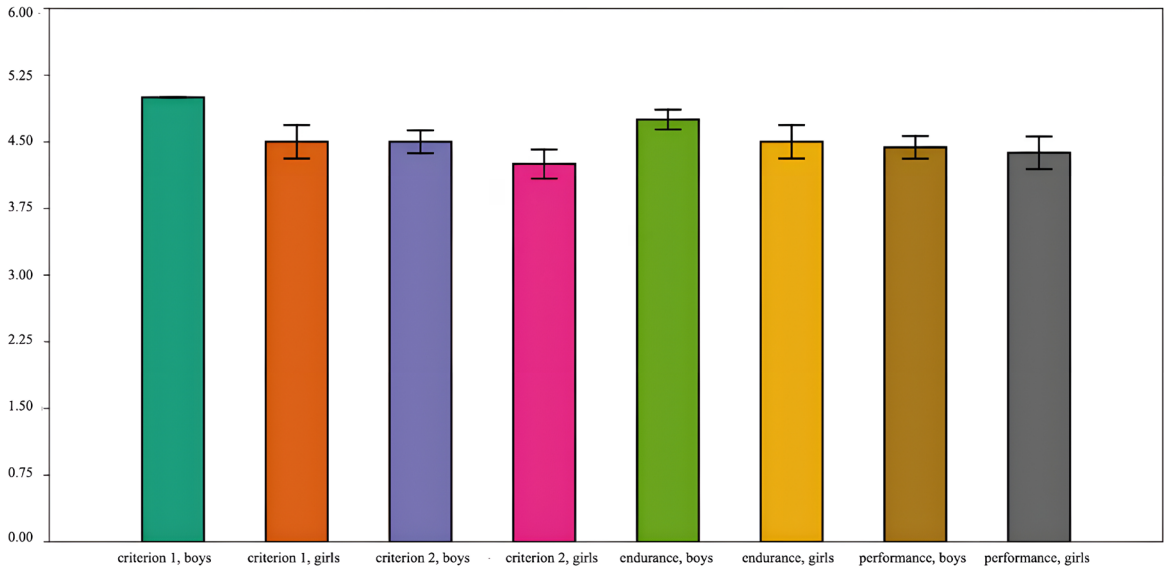
Regarding the number of excellent students, there is a trend towards Group 2 ($p \leq 0.06$). In terms of good students, Group 2 significantly exceeded Group 1 ($p \leq 0.01$). Students from Group 1 had almost evenly distributed results (from 3 to 5, Figure 8). According to the mistakes in the performance, most of the students from Group 2 attained results of 4. Most of Group 1 made a significant number of mistakes (Figure 9). Figure 10 shows the results of the comparative analysis according to three criteria (1, 2, 5) for boys and girls.

Figure 10 – The average score according to three criteria (1, 2, 5 – endurance and quality of performance) for boys and girls from Group 1. *Note*: The vertical axis is the number of points.



For Group 1, we found no significant differences in the scores between boys and girls according to all three criteria (the results of the Kruskal-Wallis test: Chi-squared =3.62, p=0.84.

Figure 11 – The average score according to three criteria (1, 2, 5 – endurance and quality of performance) for boys and girls from Group 2. *Note*: The vertical axis is the number of points.



In Group 2, there were significant differences between boys and girls according to some criteria (the Kraskel-Wallis test: Chi-squared=12.59, p=0.016). This result may be due to the different methods (standard and original) used in both groups (Figure 11). Boys showed the best results according to criterion 1 (p=0.04). According to criterion 2, there were no significant differences. As for criterion 5, the endurance levels of boys were higher (p=0.02), with no significant differences regarding performance quality. The variation in criteria is linked to the level of perception of instructional information. Undoubtedly, physiological capabilities also had an influence; however, they were indirect, as the development of skills in playing musical instruments is associated with the quality of mastery of each criterion.

Below is a more detailed analysis of each of the criteria. The formation of breathing skills was a priority in both groups, including during training. However, the results of the study indicate a higher efficiency of the new method. In Group 2, proper breathing received special attention, both before mastering new skills and throughout the experiment. It allowed students from Group 2 to develop correct skills among students and improve their results. Due to the technique, students mastered proper breathing within 3 months after the start of classes. Therefore, it became possible to correct errors in the performance technique, as well as to advance performance skills.

In Group 1, students learned the standard methods of breathing control, but they managed to apply their knowledge only 4.5 months after the start of training. Data analysis showed that there is a difference of 1.5 months between Groups 1 and 2 according to the first criterion. In addition, students with lower scores showed worse results in other criteria, and the number of these students was always higher in Group 1.

Criterion 2 included the correctness of the embouchure setting. This criterion was central for both groups. Both standard and original methods started with learning simple techniques to practice with a trumpet or without it to advance the acquired skill. At the same time, in both cases, the groups passed control tests.

The results showed significant differences, confirming the more considerable effectiveness of the original technique. Students from Group 2 mastered the embouchure technique for 4 months from the beginning of the course. In this group, 10 students showed improvements at the end of 2 months. In Group 1, it took longer to master these skills. Thus, 8 students from this group learned to control the embouchure after 2 months (against 10 students from Group 2), while the majority managed to achieve the same goals only after six months.

Consequently, the approach chosen by the authors proved to be correct. It allowed students to form the correct embouchure. The authors carefully monitored the performance of students during classes and explained the principles of the labial apparatus when playing the trumpet. In addition, we systematized students' assignments at home and in the classroom. In Group 1, the embouchure skills of students corresponded to the plan of the educational process. We also found that the parameters of the rate and efficiency of an embouchure setting are related to the type of occlusion. Students with parallel occlusion showed better results in both groups.

According to criterion 3, all students had to master the range, including upper registers. Therefore, the practice should be properly organized both in the classroom and at home. In Group 2, we focused on the convenience and freedom of performance, prioritizing it over the standard requirements for a specific result. Students from this group were not forced to perform undeveloped or uncomfortable notes. In the classroom, the students performed notes in the uppermost register every day. In parallel, students from Group 2 developed their skills in proper breathing and embouchure setting. Due to these factors, they managed to reach the maximum range (2.5 octaves). To achieve further growth, these students should practice it. At the same time, in Group 2, the working range was 1 third less than in Group 1, but this result is not negative.

Group 1 mainly used exercises, which included scales and long sounds. At the same time, the absolute values of the ranges were inferior to Group 2. There were also smaller differences in the maximum and working ranges in Group 1 compared to Group 2.

As for criterion 4, we assessed the standardization level of the wind playing technique. To pass the test, students had to perform exercises until they reached a stable level of the technique. In this case, the complexity of an exercise did not play a significant role. Both groups used exercises designed to improve technical skills. These skills create a reliable basis for the growth of the trumpeter. Students in both groups similarly performed detache. To this end, they aimed the end of the tongue at the upper alveoli. Group 2 demonstrated higher levels of performance rate and quality. The lessons of this group included rehearsals. Group 1 focused on scales and arpeggios with minor and major tonalities. Group 2 showed better results in the legato technique (there were fewer inaccurate transitions between notes). This result was due to constant exercises aimed at the positioning.

The analysis of the results in criterion 5 covered such parameters as quality and accuracy in the performance of a musical composition. Other parameters were also considered (the bowing technique, and endurance). The students with parallel occlusion showed the best results in both groups. On the exam, 4 students from Group 2 and 6 from Group 1 showed the best possible results without making a single mistake. In each group, 2 students made a mistake in legato. The rest of the students in the two groups showed average performance skills. We associate high results with the individual characteristics of students, such as the desire to learn and the appropriate methodological approach. At the same time, according to numerical indicators, Group 2 showed higher results. Thus, the applied technique was more effective for trumpet learning than the standard one.

4. Discussion

Developing high trumpet playing skills is achievable through the thorough refinement of technique. Drawing upon research (Campbell et al., 2021; Steenstrup et al., 2021), the following aspects of instruction can be formulated:

Proper lip position and pressure control: Studies emphasize the importance of proper lip position and lip pressure control when playing the trumpet. It helps to achieve optimal sound and reduces the load on the facial muscles (Campbell et al., 2021).

1. Regular breaks and warming up: Playing wind instruments requires considerable effort from the facial muscles. Regular breaks and warming up of muscles help to prevent fatigue and possible damage (Steenstrup et al., 2021).
2. Training with a physiotherapist or a musician's health specialist: Cooperation with a qualified specialist can help develop an individual training and rehabilitation program to strengthen facial muscles and prevent injuries (Van der Weijden et al., 2020a).
3. Physical fitness: Regular exercises for general physical fitness, including strengthening the muscles of the body and stretching, can contribute to better control of the instrument and reduce the load on the facial muscles (Gustad, 2022). Our study used these recommendations to address some parameters, such as the correct lip position for an embouchure setting, the level of training, and anatomical features (occlusal patterns).

In the presented studies, attention was devoted to fostering regularity in instruction and focusing on pressure control to develop trumpet playing skills. In our article, a portion of these criteria was considered (lip positioning when working with the embouchure, anatomical peculiarities), while emphasis was placed on a more comprehensive refinement, encompassing both breath control and endurance.

Studies using electromyography (EMG) show that playing wind instruments, including the trumpet, activates various facial muscles. In particular, the muscles of the lips, jaws, and tongue are under a significant load, which allows for the utilization of this approach in instruction. Scientists study the activity of these muscles in performances to determine optimal patterns of muscle activity and identify possible risks of overload or tension (Van der Weijden et al., 2020b; Weidner, 2020).

Developing trumpet playing skills can be achieved by assessing the influence of contact with the mouthpiece, the pressure on the lips, and the level of resistance that the musician must overcome to produce sound. Uncontrolled or excessive pressure can lead to muscle weakness and traumatic conditions (Smith, 2019a).

An important aspect to study is the effect of trumpet playing on the health of a musician. Uncontrolled stress on the facial muscles can result in various problems, including muscle weakness, pain sensation, muscle imbalance, as well as damage to teeth, gums, and joints. Research helps to identify factors that may contribute to or prevent these problems and develop health recommendations (Okeke, 2020a; 2020b). They may include exercises to develop and strengthen facial muscles, relaxation and warm-up techniques, training in proper playing techniques, as well as tips on instrument care and general physical condition.

In the studies presented, greater emphasis is placed on monitoring the burden on musicians to achieve superior outcomes. The findings of our research are aimed at enhancing instructional recommendations through the individualization of teaching approaches. The results of our and similar studies help to develop recommendations and programs for successful and safe performance. The presented method of teaching trumpet playing has significant advantages confirmed by the results of the study. To evaluate the effectiveness of the methodology, it was crucial to monitor students' performance at the end of the first study year. The results indicate significant progress in performance skills and quality, as well as high accuracy and standard of the position.

Therefore, the methodology fosters a stable improvement of performance techniques and serves as a good basis for the further development of students.

Other studies also confirm the importance of the standard position for playing and its impact on the quality of performance. A group of researchers demonstrated how the correct position affects the sound characteristics and stability of performance. They found that students with improved standard bowing positions had more precise and expressive performance (Twentey, 2020). In addition to standardizing the position, research also draws attention to the importance of rehearsal exercises and their impact on the accuracy and endurance of musicians. Our study showed that the systematic use of rehearsal exercises enhances the quality of performance. Due to repetitions, students can develop more solid and deep knowledge (Smith, 2019b).

Thus, the published works are aimed at investigating a limited number of parameters for the development of trumpet-playing skills. The results of this study, as well as previous research, confirm the effectiveness of the presented approach to teaching trumpet playing. It allows for the standardization of the bowing technique, improves the quality and accuracy of performance, and contributes to the development of endurance. Using this technique, educators and music teachers can help their students achieve high results in trumpet playing. Nevertheless, the control group used other methodological techniques, such as legato and detache exercises centered on scales and arpeggios. The results showed that the average performing skills in the control group were lower compared to the experimental group, especially regarding standard wind playing technique and the performance of intervals with legato. This outcome indicates the advantages of the presented training methodology in achieving higher results.

5. Conclusions

This paper proposed a new breathing method for students of musical institutions studying trumpet playing. The use of the method in practice resulted in a significant improvement in musical skills. This approach allows students to use the physiology of proper breathing to control individual muscles (abs and embouchure) with minimal strain on the body, avoiding unnecessary muscle contractions caused by other breathing methods. Students with parallel occlusion achieved better results than those with normal occlusion. Therefore, students with these physiological characteristics need to study brass instruments in more detail. For other students, it is important to devote sufficient time to the formation of the correct embouchure.

The study involved determining the effectiveness according to various criteria (breathing and embouchure placement, range development, musical articulations, and endurance parameters) for two groups of students - the control and experimental groups. To this end, two instructional approaches were employed. Students in the experimental group were provided with digital technology and individualized instruction during training. Students in the control group were trained using a traditional instructional system.

The results of the study showed that long-term independent learning proved to be highly effective. Regular execution of a certain set of exercises would allow students to maximize their potential and consolidate performance skills. Thus, although learning may be slow, exercises can prevent many technical problems that may arise with more complicated material. The results obtained in this study apply to the following areas:

1. Education and training: A new breathing technique, which improves the formation of musical skills, can be introduced into the trumpet performance curricula of musical institutions. This approach, based on breathing physiology, allows students to control individual muscles with minimal body tension.

Consequently, it is possible to learn more effectively and develop wind instrument playing skills.

2. Individualized learning: The results indicate the importance of the physiological characteristics of students when choosing a learning tool. Students with parallel occlusion demonstrate the best results on brass instruments. Therefore, these students would learn more successfully under the new approach. At the same time, other students need to devote sufficient time to the formation of the correct embouchure to achieve optimal results.

Some possible directions of future research can include the following:

1. The long-term effects of the new breathing method and its impact on the professional development of musicians.
2. A wider range of physiological characteristics and their connection with the choice and professional development of musicians playing wind instruments.
3. The development of individualized training programs based on the physiological characteristics of students and their impact on learning outcomes and professional development.
4. The impact of various aspects of training and regular exercises on the long-term stability of musical skills; the prevention of possible injuries and problems associated with playing a wind instrument.

These areas of research can shed light on optimal approaches to the training, health, and development of musicians. Additional studies may contribute to the improvement of professional practices in the field of music education.

References

CAMPBELL, Murray; GILBERT, Joël; MYERS, Arnold. **The Science of Brass Instruments**. Cham: Springer, 2021.

CHESKY, Kris; DEVROOP, Karendra; FORD, James. Medical Problems of Brass Instrumentalists: Prevalence Rates for Trumpet, Trombone, French Horn, and Low Brass. **Medical Problems of Performing Artists,** v. 17, n. 2, p. 93–98, 2002. https://doi.org/10.21091/mppa.2002.2013

CLEMENTE, Miguel Pais; MENDES, Joaquim; MOREIRA, André; FERREIRA, Afonso Pinhão; AMARANTE, José Manuel. Craniofacial Morphology of Wind and String Instrument Players: A Cephalometric Study. **BMC Medical Imaging**, v. 20, n. 1, p. 57, 2020. https://doi.org/10.1186/s12880-020-00455-6

DUEPPEN, Matthew D. **The Benefits of Nutritional Supplementation for Building the Muscles of the Trumpet Embouchure.** Dissertation. Tallahassee, FL: The Florida State University, 2021.

GARNETT, Ron; PIJL, Em M.; VISENTIN, Peter. Are Factors of Posture and Balance Integrated in Research Studies on Upper Extremity Musculoskeletal Pain in Instrumental Musicians?: A Scoping Review. **Medical Problems of Performing Artists**, v. 37, n. 4, p. 278–292, 2022. https://doi.org/10.21091/mppa.2022.4032

GUSTAD, Taylor. **Momentary Endurance: The Effects of Mouthpiece Pressure and Capillary Refill Time on Short-Term Muscle Recovery in Trumpet Players**. Dissertation. Lexington, KY: University of Kentucky, 2022.

HERRMANN, Noëla; JUST, Melissa; ZALPOUR, Christoff; MÖLLER, Dirk. Musculoskeletal and Psychological Assessments Used in Quantitatively Based Studies about Musicians' Health in Brass Players: A Systematic Literature Review. **Journal of Bodywork and Movement Therapies**, v. 28, p. 376–390, 2021. https://doi.org/10.1016/j.jbmt.2021.07.020

KOK, Laura M.; KRAAL, T.; VAN NOORT, A. How to Treat Musicians with Frozen Shoulder: A Narrative Review. **Medical Problems of Performing Artists**, v. 36, n. 2, p. 129–138, 2021. https://doi.org/10.21091/mppa.2021.2015

LASSERON, M. Music and Medicine. **Medical Humanities**, v. 34, n. 2, p. 118–119, 2008. https://doi.org/10.1136/jmh.2008.000729

LÓPEZ-PINEDA, Javier; RODRÍGUEZ-MARTÍNEZ, María Carmen; GÓMEZ-RODRÍGUEZ, Rosa; GARCÍA-CASARES, Lucía; GARCÍA-CASARES, Natalia. Biomechanical Assessments in Woodwind Musicians: A Systematic Review. **Healthcare**, v. 11, n. 11, art. no. 1621, 2023. https://doi.org/10.3390/healthcare11111621

MATSUNOBU, Koji. Reinventing Folk Instruments as Educational Tools: The Case of the Shakuhachi. **Research Studies in Music Education**, v. 45, n. 1, p. 77–93, 2023. https://doi.org/10.1177/1321103X221123272.

MOSS, Hilary; DONNELLAN, Claire; O'NEILL, Desmond. A Review of Qualitative Methodologies Used to Explore Patient Perceptions of Arts and Healthcare. **Medical Humanities**, v. 38, n. 2, p. 106–109, 2012. https://doi.org/10.1136/medhum-2012-010196

NICOLAS, Botella Ana Maria; CARBONELL, Guillem Escorihuela. Evolution of the Flute Methods from the 18th to the 20th Century and Their Use in the Higher Conservatories of Spain. **Musica Hodie**, v. 19, art. no. e57958, 2019. https://doi.org/10.5216/mh.v19.57958

NWOBI, Samuel Oluchi; OJUKWU, Ebele V. Chapter Seventeen: Enhancing the Learning and Teaching of Trumpet through Simplified Approach: A Case Study of Austica Memorial Collage, Nanka. In: **Festschrift in Honour of the Music Maestra Professor Young-Sook Onyiuke**. Awka: ArchRock Creatives Media Ltd., 2022. p. 150–159

OKEKE, Ikedimma Nwabufo. On the Theory of 'Adaptive Musicology'. **HOFA African Journal of Multidisciplinary Research**, v. 5, n. 1, p. 56–68, 2020a.

OKEKE, Ikedimma Nwabufo. Physiological Considerations in Learning of Musical Instruments. **Awka Journal of Research in Music and the Arts**, v. 14, p. 101–125, 2020b.

SAMBRE, Paul. Taking the Trumpet up There: Enactment of Embodied High Pitch in a Multimodal Body Schema. **Linguistics Vanguard**, v. 7, s4, art. no. 20200114, 2021. https://doi.org/10.1515/lingvan-2020-0114

SMITH, Alden. **Embouchure Theory in Practice.** Senior Research Project. Akron, OH: The University of Akron, 2019a.

SMITH, Alden B. **Developing Musicians out of Instrumentalists: A Comprehensive Guide to Improve Intonation Skills in Intermediate Band**. Master's Thesis. St Charles, MO: Lindenwood University, 2019b.

STEENSTRUP, Kristian; HAUMANN, Niels Trusbak; KLEBER, Boris; CAMARASA, Carles; VUUST, Peter; PETERSEN, Bjørn. Imagine, Sing, Play- Combined Mental, Vocal and Physical Practice Improves Musical Performance. **Frontiers in Psychology**, v. 12, art. no. 757052, 2021. https://doi.org/10.3389/fpsyg.2021.757052

TROLLINGER, Valerie L.; SATALOFF, Robert T. Respiratory Behaviors and Vocal Tract Issues in Wind Instrumentalists, Part 1. **Journal of Singing**, v. 76, n. 2, p. 171–179, 2019.

TROLLINGER, Valerie L.; SATALOFF, Robert T. Wind Instrument Technique, Function, and Evaluation: An Overview. In: Hamdan, A. L., Sataloff, R. T., Trollinger, V., Hawkshaw, M. J. (Eds.). **Dentofacial Anomalies.** Cham: Springer, 2021. pp. 49–69. https://doi.org/10.1007/978-3-030-69109-7_4

TWENTEY, Daniel. S**elected Published Literature Concerning Trombone Embouchure: An Evaluation and Reference.** Dissertation. Boulder, CO: University of Colorado Boulder, 2020.

VAN DER WEIJDEN, Fawn N.; HAZENBERG, Cees J. M.; VAN DER KAAIJ, Nicoline C. W.; KUITERT, Reinder B. A Case Series of Wind Instrument Players with Cleft Lip and/or Palate. **British Dental Journal**, v. 234, n. 4, p. 223–231, 2023. https://doi.org/10.1038/s41415-023-5510-9

VAN DER WEIJDEN, F. N.; KUITERT, R. B.; LOBBEZOO, F.; VALKENBURG, C.; VAN DER WEIJDEN, G. A.; SLOT, D. E. Does Playing a Wind Instrument Influence Tooth Position and Facial Morphology? **Journal of Orofacial Orthopedics / Fortschritte der Kieferorthopädie**, v. 81, n. 4, p. 267–285, 2020a. https://doi.org/10.1007/s00056-020-00223-9

VAN DER WEIJDEN, Fawn N.; LOBBEZOO, Frank; SLOT, Dagmar E. The Effect of Playing a Wind Instrument or Singing on Risk of Sleep Apnea: A Systematic Review and Meta-Analysis. **Journal of Clinical Sleep Medicine**, v. 16, n. 9, p. 1591–1601, 2020b. https://doi.org/10.5664/jcsm.8628

WEIDNER, Brian. The Trumpet. In: **Brass Techniques and Pedagogy**. PALNI Press, 2020. pp. 139–151

Research ethics committee approval

The study was conducted in accordance with the rules of the Declaration of Helsinki. The study protocol was approved by the Ethics Committee of Shenyang Conservatory of Music (Protocol no. 467 dated from 02/02/2019).

Publisher

Federal University of Goiás. School of Music and Performing Arts. Graduate Program in Music. Publication in the Portal of Periodicals UFG.